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REFORM OF THE MACHINERY OF GOVERNMENT

ONE of the merits of the lectures on freedom under the law which Lord Justice Denning delivered last autumn at the Senate House of the University of London is that they view from a fresh angle certain questions of vital importance in the re-orientation of government and in the exercise of Parliamentary control. The publication of the lectures will enable a wider circle than those who attended them to study the principles he lays down (see *Nature*, December 31, 1949, p. 1101). These principles, indeed, should help to correct some of the muddled thinking which has been apparent on many occasions when the structure of the organisation of government has come into question, to which it is probably fair to attribute the partisan and political feeling which has been allowed to embitter and to confuse the discussion of what is essentially a non-party matter and demands, above all, a scientific approach if all the relevant factors are to be appraised objectively.

The complexity of this problem of the most appropriate organisation of government is obvious, whether we approach it at the level of the Cabinet, at that of parliamentary or public control or at that of the training, recruitment and numbers of the Civil Service responsible for executing policy and the day-to-day tasks of central government. Any question, for example, of reducing the size of the Civil Service cannot be considered apart from the tasks which the Service is called upon to discharge, and the new functions which it is required to serve in consequence of the conscious intervention of the Government in the everyday affairs of the country. Whatever opinions may be held as to the extent to which such intervention should go in particular fields, it is widely agreed that post-war conditions demand a greater degree of government control and that much of it is likely to continue. A consideration of general policy would necessarily precede any reduction in the size of the Civil Service, and even the review of methods which is continually proceeding under the Organisation and Methods Division of the Treasury. The effectiveness of such a review in promoting a high standard of efficiency and in securing the utmost economy of man-power depends largely on the attitude of those at the top, and the support it receives from Cabinet, level. Frustration is easily caused if there is no response at that level when proposals for eliminating useless returns or forms of activity are formulated, and all the more when the larger prospects for economy in man-power are seen to lie in the proper arrangement of government departments and in their relations with the public boards and nationalized industries so as to avoid duplication of effort.

It was suggested in the debate in the House of Commons on October 26 on economic policy that some redistribution of departments might offer possibilities of economy, or even that certain departments could be abolished. That is a small point besides the re-grouping of departments to secure greater efficiency, though economy of man-power would certainly follow from such re-adjustment. Some of the measures to that end, such as the grouping of the defence ministries under the Minister of Defence, have scarcely been promising, however sound in theory, and some fundamental thinking on the functions to be served should precede any further re-arrangements. It is easy to point to anomalies in the duties or even the existence of certain ministries: the relations of the Ministry of Civil Aviation and the Ministry of Transport, of the Ministry of National Insurance and the Ministry of Pensions, for example, might well be examined in this connexion, and the position of the Ministry of Supply in relation to the Board of Trade, or the Ministry of Town and Country Planning, at least so far as co-ordinating duties are concerned, in relation to the Home Secretary, who would seem *a priori* to be more appropriate for discharging those duties of dealing with conflicting claims which the present Minister has found so much beyond the powers of his office. There are anomalies in the responsibilities of the Ministry of Health; and the distribution of overseas responsibilities between Foreign Office, Commonwealth Relations Office and Colonial Office might appropriately be reviewed at the present time.

There is required to-day fundamental thought and re-examination on this issue comparable with that which the Haldane Committee brought to bear upon it thirty years ago. It would be reassuring to learn that the Cabinet Committee considering the machinery of government is dealing with the problem on such lines. All that has happened in this field during the past two years reinforces Dr. W. A. Robson's reasoned criticism in the *Political Quarterly* early in 1948 of the secret proceedings of that Committee, and his plea for public discussion and for impartial and objective examination of the whole subject by a committee the members of which combine exceptional ability, great experience of public affairs, disinterestedness and freedom from ministerial preoccupations. Dr. Robson then suggested that the emergence of a ministerial hierarchy and the concentration of power in the hands of five or six ministers called for reflexion. The positive conception of government is now generally accepted, but the matter of what is termed delegated legislation alone has made apparent the need for further thought about the ultimate purposes that the organisation of government is to serve. A clear conception of those purposes or ends should precede a final decision on the means by which the ends of government are to be achieved. Moreover, experience of delegated legislation alone has led to widespread apprehension that the growing complexity and scale of central administration is fraught with grave dangers to the individual—that, even in a democracy, abuse of the executive power may readily lead to tyranny and to frustration in science, art and all the cultural activities which are the glory of the Western tradition of freedom.

It is important, therefore, that any new adaptation of the organisation of government should be worked out in the light of public debate and in full awareness of the weaknesses which at present lead to injustice or dissatisfaction among different sections of the community. It is not enough even [illegible] rectify such absurdities as the persistence of minor war-time controls long after they have served their purp The large majority of the 21,000 persons [illegible] with during 1948 in magistrates' courts for brea Defence Regulations are not criminals. Such incidents as the fining of the farmer and his wife for serving to a casual visitor a saucer of the surplus cream left on their hands from feeding calves on skimmed milk bring the law into disrespect, and it will not suffice merely to amend a stupid regulation. There must be searching inquiry into how regulations of this type are brought into being and allowed to run one day beyond the very minimum they serve the public interest.

Some attempts have been made to determine how far consultation may eliminate the risk of delegated legislation bearing unfairly on individuals, and to define the principles which should be regard Clearly much depends on how far the partic legislative proposals directly affect private int and not merely the internal working of a departm Much depends, too, on the extent and variety of su private interests, and the practicability of rea ascertaining what they are and whether they h truly representative organisations. The futility of consultative method has already been demonstra in particular instances in connexion with the nation ized industries. Again, the scope of parliamenta and judicial review may eliminate the need for a pub voice in making delegated legislation, and apart from the safeguard of delaying the effect of a particular proposal, a statute might well require a Minister to state what bodies he has in fact consulted before making his order.

There is more involved here than putting an end to the practice of administrative convenience being allowed to override personal freedom: the linking of power with responsibility, and the termination of a spreading practice of departments or individuals being allowed to be judges in their own cause, an sometimes the utilization of the services of th scientific and technical expert, may equally enter int the establishment of an appropriate procedure o code. There has been much evidence of this in rece months, and it is worth while examining it. Pa ticularly is it desirable that this should be done unde conditions where party and personal consideration can be excluded.

First, then, there is the matter of the public boar The Lord President of the Council has consistent recognized that we have yet to find the answer the question how such bodies as the National Co Board can be controlled in the public interest without being hampered by detailed interference. Mr Morrison recognizes, too, the need for experimen and has endeavoured to keep this issue clear of pa clashes on the merits or demerits of particu nationalization proposals. While it may well be t there is no one method of control which can be appl uniformly to all the various boards responsible coal, transport, electricity and gas, it is importa that we should find a satisfactory answer to t question during the next few years. Nor can sume that the public boards formed before the War are operated altogether satisfactorily from the point of view of parliamentary control. Even the staffing of such bodies, including the remuneration of Ministers, permanent officials and members of the national boards, cannot be entirely disregarded in considering recruitment and training for the Civil Service, on which the effects of undue disparity of terms may well be serious.

In the recent debate on the work of the Coal Board, Mr. Gaitskill's sensible and thorough review contributed little towards finding an answer to this general question. Indeed his review, with its implication that the Minister must be concerned to defend the Board rather than to watch it in the public interest, brought out the same fundamental weakness in the present structure of the nationalized industries as Mr. Strachey's defence of the Overseas Food Corporation in a later debate. The evidence is uniform that the undertakings are being run by the boards and the Ministers working together, not by the boards themselves with Ministers outside watching as part of the machinery for controlling a monopoly in the public interest. Nor have any of the debates yielded evidence that the Government is thinking about the methods which might be used for public control of nationalized monopolies.

Outside Government circles there has been a considerable amount of discussion. Besides the reconsideration of the use of the Parliamentary question —and it has been urged that the latter can have a stimulating rather than a deadening effect—one proposal that has been advanced is investigation by a 'select committee', provided with an adequate staff, and a subsequent long and full debate in the House of Commons every two or three years on the basis of the committee's reports. Such a procedure would seem to offer a means of controlling the strategy of nationalized industries and other like undertakings and of applying a periodical efficiency audit without the detailed interference which would lead to a paralysing centralization. It would not, however, provide for that check on individual injustice which the Parliamentary question provides over the Departments of State, and it is at this level that further thought is desirable to meet the need which Lord Justice Denning stressed.

In the review of its programme which Political and Economic Planning issued in October 1948, an outline was given of a P E P inquiry designed to examine the relations between government and industry and to establish the criteria by which such relations may be judged. The inquiry postulates a broad acceptance of the need for common purpose in post-war Britain, and a general conviction that such a purpose cannot be achieved without some degree of guidance and positive action from the centre. It assumes, also, that during the next decade the major portion of the nation's economy will remain in private hands, and that the government will aim at the minimum degree of interference consistent with achievement of the nation's purposes; and the broadsheet points to some assumptions as to the relation between nationalized and private industry.

While the inquiry faces frankly such fundamental questions as the nature of the common purpose and of the general decisions which government has to take, the division of responsibility between government and industry for the execution of policy, the methods and machinery by which policy is drawn up in collaboration with industry, and how to ensure that the many detailed actions are duly carried out by those who have to conduct the business of industry, commerce and finance, it does not seem certain that the inquiry will touch this aspect of freedom and law which has just been stressed. It is more likely, however, to throw light upon the other problem, namely, the utilization of the scientific and technical expert. The importance of that factor in the East African groundnut scheme has been almost eclipsed by the political and personal issues; but the success of such undertakings, no less than of the National Coal Board, of the gas and transport authorities and the British Electricity Authority, depends not only on effective parliamentary control but also on our ability to provide an organisation in which the scientific and technical expert can work effectively, and make representations at the proper level in order to determine decisions of procedure and policy when necessary.

That is one aspect of a matter which the Cabinet Committee should be considering. Another aspect is related to the question of individual justice, as has been well illustrated in the debates over the Minister of Civil Aviation's rejection of a finding of the court of inquiry into the Prestwick air accident. The Attorney-General, Sir Hartley Shawcross, in his speech in the House of Commons on December 8, went a long way towards removing the real grounds for concern which Lord Pakenham had failed to remove in the House of Lords debate. Sir Hartley Shawcross maintained, and with reason, that the findings of a quasi-judicial tribunal could not be binding on a Minister; but when he conceded that the Minister's dissent should have been conveyed in the first instance to the House of Commons and that the reasons for that dissent should have been made known, he disposed of that aspect which touches the scientific and technical expert most closely.

The very multiplicity of organisations under government and semi-government control, and the increasing number of those who in some sense or other are employed by the State, make it the more imperative, as Lord Justice Denning urged, that the most meticulous care should be taken to safeguard the rights of the individual citizen.

The Attorney-General has also discussed, before the Institute of Journalists, the law of libel in connexion with the freedom of the Press, which is parallel with the freedom of the individual. The Press should have the same freedom to talk and to criticize as he claimed for himself, and Sir Hartley said further that it would be a great disservice to Parliament and to the public interest if Parliament tried to assert rights and powers which were not absolutely necessary. It may reasonably be hoped that time will be found in the next Parliament for the unspectacular business of bringing order into this branch of the law, which is as important for the preservation of freedom as it is at present capricious.

It need not be emphasized further that with the increasing association of the man of science and technical expert in the tasks of government at every level, this is a matter of vital importance. Scientific workers cannot be expected to co-operate freely in such work if the liberty of comment and criticism, above all on matters of fact, is withheld. The detailed recommendations of the Porter Committee on the law of libel were largely directed towards giving additional protection to the responsible dissemination of facts and opinions in the public interest; and it is necessary to insist that the review of the whole structure of government, which is now overdue at all levels, carries with it as corollary legislative measures such as the reform of the law of libel, and the establishment of independent quasi-judicial or judicial tribunals to provide effective safeguards against the abuse of executive powers or the failure of central government to maintain the vital touch with the outlook and mind of the ordinary citizens whose needs it exists to serve. Remote control to some extent is unavoidable to-day, but the conditions for securing and maintaining the essential adaptability and co-operation need continuous attention; and unless they are found the new forms of organisation and new powers which the central executive authority requires may lead to the totalitarian and not to the welfare estate, and to the decay rather than the advance of science itself.

METAL CATALYSIS IN CELLULAR METABOLISM

Schwermetalle als Wirkungsgruppen von Fermenten

Von Otto Warburg. 2 Auflage. Pp. 195+4 plates. (Freiburg i.Br.: Editio Cantor G.m.b.H., 1949.) n.p.

PROF. OTTO WARBURG'S interest in different aspects of cellular respiration goes back as far as 1908. Since more than ten years prior to the publication of this book the main activity in his laboratory was transferred from the study of metal catalysis to that of other problems of cellular metabolism, in writing this book the author probably had three objects in view: to give a more adequate summary of the work carried out by himself and his co-workers; to make a general survey of the field covered by the title of the book; and to give a much-needed account of the historical development of the subject.

As an account of the work by the author and his co-workers, the book deals mainly with the period when they were actively engaged in the study of the effect of carbon monoxide on respiration, and the photochemical absorption spectrum of the "respiratory or oxygen-transporting ferment". However, to a reader who wishes to repeat their experiments or to extend them to other materials, the account given in this book, valuable as it is, can scarcely replace the two original papers, those by Warburg and Negelein (1929) and by Kubowitz and Haas (1932), which can be considered as examples of the best experimental work in this field of research. Since the theoretical and experimental aspects of this work are widely known and have already reached text-books, they need not be discussed here. The book also deals with several other problems of metal catalysis, among which one may mention the function of metals in fermentation as revealed by the inhibitory effects of certain metal-binding substances, the copper-protein nature of the phenol oxidase of potatoes discovered by Kubowitz, the interesting work by Bucher and Negelein on photodissociation of carboxy-hæmoglobin and carboxy-myoglobin, and the work by Prof. Warburg and Lüttgens, who found that *Chlorella*, chloroplasts of green leaves or even a suspension of granules obtained from disintegrated chloroplasts, reduce quinone to hydroquinone in light with the evolution of molecular oxygen. The fact that this oxygen evolution is inhibited by phenantrolin and that the inhibition is more or less completely abolished on addition of zinc or iron suggests, according to these workers, that metal catalysis plays a part in the activity of this system. The last chapter deals with the problem of quantum requirements of carbon dioxide assimilation which, although it lies outside the scope of the book, will nevertheless be appreciated by readers interested in the problems of photosynthesis.

There is no doubt that in so far as it is a review of the work of Prof. Warburg and his co-workers, this book will be very helpful to the reader in guiding him through the rich experimental material recorded in their important original publications, and in focusing his attention upon the results of the work which are now considered by Prof. Warburg as their chief contribution to the subject.

In spite of its title, the book, however, owing to several omissions, can scarcely be considered as a general review of metallo-protein catalysts. Thus, the discussion of peroxidase and catalase is confined to a critical examination of the work of Willstatter, Hennichs, Wieland and others carried out between 1918 and 1926, whereas the hæmatin nature of these enzymes and their interesting properties revealed by subsequent studies are not even mentioned. Neither is there any reference to carbonic anhydrase, although the identification of zinc as its active group established for the first time a physiological function of this widely distributed metal.

It is the author's approach to the development of our knowledge in this subject that deserves special consideration. Unfortunately, in dealing with this interesting aspect of the subject the author missed a great opportunity, and in this respect the book is disappointing. Instead of presenting the reader with a well-balanced historical account, which could undoubtedly have been one of the most instructive features of the book, the author revives his old controversies, applying to them all the vigour and skill of an experienced polemist. However, once this attitude is adopted, the desire to score a few points over his supposed opponents prevents the author from appreciating fully the real significance of their work. Moreover, the historical development of the subject outlined in the preface and more fully developed in different chapters of the book raises several points which call for a critical examination.

(*a*) Although Claude Bernard (1857) observed that in cases of cyanide poisoning the venous blood is red, one cannot ascribe to him the discovery of the specific inhibitory action of cyanide on cellular respiration. In fact, even in 1859 he had no clear view as to the mechanism of the respiratory relationship between blood and tissues, believing "that th venous blood owes its black coloration to carbonic acid" and that "It is infinitely probable that carbonic acid of venous blood results from an oxidation which is brought about within the red corpuscle itself". It must be remembered that the absorption spectrum of oxygenated blood was discovered only in 1862 and that of deoxygenated blood in 1864, the year when the terms 'hæmoglobin' and 'oxyhæmoglobin' were introduced into the literature. Moreover, the development of the idea that the respiration of an organism is localized not in its blood but within its tissues had a long and complicated course. It began with the work of Spallanzani published in 1807 and was completed only by the work of Pflüger (1872–75), who demonstrated that respiration is an intracellular process, a view which required another twenty years for consolidation and general acceptance.

(*b*) The reader, especially of the younger generation, not familiar with the subject of charcoal–iron models, must be reminded that charcoals as they are prepared from blood or from hæmin have no more in common with hæmatin compounds than charcoal–iron prepared from Bismarck brown or safranin. The work of Prof. Warburg with Negelein and Brefeld between 1921 and 1924 on the properties of these charcoals, however interesting it was from a physico-chemical point of view, has not been very helpful in the study of the mechanism of intracellular oxidation reactions.

(*c*) Suggestions that metals form the active groups of certain oxidizing enzymes were put forward by Bertrand (1897) for manganese and by Spitzer (1897) for iron. It was also known that the respiration of cells and the activity of certain enzymes are strongly and reversibly inhibited by cyanide. But it is to Prof. Warburg that we owe the first clear formulation of the view that these inhibitory effects are due to combination of cyanide with the catalytically active metals. Although strong evidence was thus available that metal catalysis plays a fundamental part in cellular respiration and in the activity of certain enzymes, no unequivocal experimental proof could be obtained that the metal is iron. Prof. Warburg's criticism of Willstatter's work on peroxidase is therefore unjustified. Willstätter could not logically prove in 1923 that the iron forms part of peroxidase, since his purification was not advanced far enough beyond the point when all extraneous iron had been removed. Yet to reach at that time the enzyme purity even of 40 per cent was in itself an outstanding achievement, and Willstätter's work on peroxidase was the basis of all subsequent studies which have led to the elucidation of the chemical structure of this enzyme. In this respect it may be recalled that in 1928 Prof. Warburg expressed a very discouraging view as to the possibility of isolation and purification of enzymes (*Naturwiss.*, 16, 345; 1928), notwithstanding the fact that already in 1926 urease had been obtained in pure crystalline state.

(*d*) The position of Mac Munn's work (1884–87) in the history of the subject is of special interest. In fact, had his observations been recognized by his contemporaries or by generations of workers who followed, the study of the mechanism of cellular respiration, and especially the work of Prof. Warburg between 1908 and 1926, would have traced a very different and less winding course. New lines of study would have been opened up much earlier, and the workers would have been spared much unnecessary labour and discussion. Unfortunately, Mac Munn's important work was lost for more than forty years; but the events leading to the rediscovery of intracellular hæmatin compounds in 1925 did not follow the artificially reconstructed path developed in this book. Prof. Warburg's attempts to find in the literature prior to 1925 some evidence of the existence of intracellular hæmatin catalysts have not met with success. Thus, his quotation from Hans Fischer's paper of 1924: "Von der Richtigkeit der Mac Munnschen Befunde bin ich überzeugt" is taken from a paragraph which clearly shows that Fischer, on the basis of Günther's published work, believed that what Mac Munn had discovered was myoglobin. Moreover, in 1925 Fischer and Fink repeatedly stated that although porphyrin could easily be obtained from different species of yeast they failed to find in them any indication of the presence of hæmatin compounds (*Hoppe-Seyl. Z.*, 150, 243; 1925). Prof. Warburg's quotation from Harrison's paper of 1924, with the missing words added in italics, reads as follows: ". . . *and as* it is probable that oxidations in the tissue may be catalysed by organic *iron* compounds allied to hæmatin, *the smaller inhibition by cyanide would be expected*". This view was put forward by Harrison only as an attempt to explain his failure to obtain any marked inhibition by cyanide of the oxygen uptake by a mixture of oxidized glutathione and a suspension of finely divided rat muscle that had been boiled and dried in alcohol. Apart from the fact that Prof. Warburg could scarcely accept the relationship between the above system and tissue respiration, it is the high, and not low, sensitivity of tissues towards cyanide that was justly regarded by him as important evidence for the role of metal catalysis in cellular respiration.

One cannot see how such hints could lead any research worker to the study of intracellular hæmatins. It is therefore not surprising that Prof. Warburg did not make use of these or other similar hints in his lecture delivered on April 29, 1925, in which he gave an excellent account of his views on the nature of "the respiratory ferment" based primarily upon the study of charcoal–iron models and the estimation of the total iron contents of cells or tissues in relation to their respiratory activity (*Berichte*, 58, 1001; 1925).

The reader, in his attempt to understand better the aim of the author, will possibly turn his attention to a quotation from Pasteur used as the 'motto' to this book. The misleading appearance of this motto, which has recently been mistaken for a quotation from a letter of Pasteur to Berthelot, is due to its faulty transcription. In fact, it should read as follows, the missing words again being given in italics: "Comment *M. Berthelot* n'a-t-il pas senti que le temps est *le seul juge en cette matière et* le juge souverain? Comment n'a-t-il pas reconnu que du verdict du temps je n'ai pas à me plaindre?" These were the words of challenge of Pasteur to Berthelot in the course of one of their dramatic discussions which took place in the Paris Academy of Sciences on February 10, 1879. This discussion, which concluded their twenty-year-old controversy, was revived following the unfortunate publication by Berthelot of Claude Bernard's incomplete and inconclusive notes, which appeared to throw doubt upon the whole of Pasteur's work on fermentation.

One can scarcely escape the impression that had Prof. Warburg full confidence in the meaning of Pasteur's words, this book would have been written in a different spirit: as it is, this 'motto' reflects a certain feeling of disappointment. Yet the author has no reason to complain that his work has not received its due recognition.

D. KEILIN

PROGRESS IN CELL BIOLOGY

Experimental Cell Research

Edited by Torbjörn Caspersson and Ludwik Monné. Supplement 1. (Proceedings of the 6th International Congress of Experimental Cytology, Stockholm, July 10th–17th, 1947.) Pp. xi+604. (Stockholm: Wenner-Grens Institute and Albert Bonnier; New York: Academic Press, Inc., 1949.) n.p.

THIS volume is of importance for several reasons. The Sixth International Congress of Experimental Cytology at Stockholm in 1947 (see *Nature*, 160, 443; 1947) was the first of its kind after the War; it marked the re-establishment of the necessary international contacts between biologists, and gave a résumé of the work that had been in progress in each country during and since the war years.

The appearance of this book marks the inception of a new international journal for experimental cytology, which thus begins with a supplement. The need for such a journal is deeply felt by all students of cellular biology, who would wish those responsible for this new venture every success. Prof. T. Caspersson and Dr. L. Monné have undertaken the very considerable task of editing the present volume. It is perhaps ungenerous to complain that some of its value has been lost by its appearance two years after the Congress has taken place. No doubt the editors share this view. It is likely that many of the authors of these contributions could now add much to the reports that they gave to the Congress more than two years ago.

In this volume there are more than 120 separate entries which range in subject from the chemistry of strains of tobacco mosaic virus to the transplantation of the eyes of salamanders. There will be little doubt that the most distinguished contribution is Prof. K. Linderstrøm-Lang's lecture on the profound and still obscure subject of protein synthesis. At this Congress, specially prominent were new techniques such as cell fractionation methods and electron microscopy. The latter is the subject of six papers in this volume, which well illustrate the varying fruitfulness of the application of the electron microscope to different biological material and problems. The studies on striped muscle fibres and isolated muscle proteins of Jakus and Hall are of acknowledged importance; but it may be doubted whether the pictures of smears from glioma cells in the paper by Dr. H. Fernández-Morán bear any relation to the structure of living cytoplasm. The contributions from Prof. Caspersson's own institute are limited to two short papers, one by Drs. B. Malmgren and C. G. Hedén on nucleotide metabolism in bacteria, and the other by Dr. B. Thorell on erythropoesis. The work of both has already been published elsewhere in full.

One doubts whether the width of interest of many biologists will be sufficient to induce them to read the whole of this large volume, and reports of such large Congresses might well enjoy a wider circulation if they could be split into two or even more sections, each perhaps with the major 'set-pieces' of the Congress. Though it is obvious that the use of a finer screen for the plates and better paper would have added greatly to the cost of this volume, it is greatly to be hoped that the standard of reproduction of photomicrographs in the journal proper will be a higher one.

ARTHUR HUGHES

MENTAL HYGIENE FOR THE STUDENT AND TEACHER

Psychology of Personal Adjustment

Student's Introduction to Mental Hygiene. By Pr Fred McKinney. Second edition. Pp. xi+752+ plates. (New York: John Wiley and Sons, Inc London: Chapman and Hall, Ltd., 1949.) 36*s*. n

THE author of this book states that it is " accumulation of suggestions from psychologica biological, sociological and educational literatur which the student may use in developing his personality with the facilities on the campus". The aim of it is to enable him to attain personal adjustment, and, by doing so, to reach adult emotional status. It is a text-book of practical mental hygiene by an experienced educational psychologist—the author is professor and chairman of the Psychological Department of the University of Missouri.

The book itself is composed of papers which can be read either separately or in sequence as chapters The sections are devoted to such subjects as adjus ment to college work; concentration, learning an thinking; personal efficiency; understanding o self; development of personality; creative adju ment; social proficiency and leadership; affecti and conventions; marital adjustment; emotio stability; self-confidence, and so on. At the end each chapter is a list of references, about six hundr in all, and everything is adequately documente All this must represent an enormous amount work.

Unfortunately the book is grossly marred by excess of Americanisms which are often unintelligi to other English-speaking readers. Such expressi as "bull-sessions", "yell-leaders" and so on puzzling. Here is an extract from a case-history where the worst of such are to be found "The b in the case had just caught a punt with his use deftness when two ends crashed into him, hurli him to the ground". Yet, in spite of these obvio blemishes, there is a great deal of valuable materi here. Much of it would be difficult for the s [illegible] unearth for himself from the literature: this i particularly so in the case of the chapters on th technique of work and the psychology of study. certain amount of the social side is not much relat to British life, and a little of the writing has a flavo of uplift which may repel some people.

It is mainly because of the style that the book do not give the impression of going very deeply into th material which, indeed, does cover a very large fiel This feeling is increased by the fact that the psych logical chapters deal with the student's problem mainly from the point of view of consciousness an neglect the deeper unconscious factors in maladjus ment. Some of the suggestions for dealing wi emotional derangements have been taken fr questionnaires filled in by students and cannot expected to be of much value. Depression, f example, is unlikely to be improved by the suggest brisk walk, and so on.

Apart from the faults which have been noticed, is obvious that the book has been written wit honest intention, and does make a real attempt t penetrate into the student's difficulties. It is w printed on good paper with adequate illustratio The index is comprehensive and covers thirty-thr pages. The binding is pleasing.

CLIFFORD ALLEN

tomic Energy Levels

Derived from the Analyses of Optical Spectra. . 1: The Spectra of Hydrogen, Deuterium, ium, Helium, Lithium, Beryllium, Boron, Carbon, rogen, Oxygen, Fluorine, Neon, Sodium, Mag- sium, Aluminium, Silicon, Phosphorus, Sulfur, lorine, Argon, Potassium, Calcium, Scandium, anium and Vanadium. By Charlotte E. Moore. nited States Department of Commerce: National reau of Standards, Circular 467.) Pp. xliii+309. ashington, D.C.: Government Printing Office, 949.) 2.75 dollars.

THIS is the first volume of a series of three or four from the American National Bureau of Standards aimed at bringing up to date and replacing Bacher and Goudsmit's well-known "Atomic Energy States" (1932). Elements are being dealt with in order of their atomic number, and the first twenty- ive elements covered in the present volume natur- lly include many of the most important.

A few pages of introduction give information on he layout and the system of spectroscopic notation, ith tables of values of Landé g-factors, lists predicted term-types for various iso-electronic quences, and ionization potentials for all elements. e main tables give the designation, configuration d term energies, always expressed in cm.$^{-1}$ above e lowest term as zero. Data appear to be very nplete for the elements covered, and include some erences up to 1949 and some hitherto unpublished ults.

This is a most valuable work, and the author and se associated with her are to be congratulated on ting through the laborious work of compiling this t volume. The scope of the book is, of course, ited. It only gives energy-levels, and for most rk requiring actual wave-lengths or wave-numbers lines it is still necessary to refer to original papers. it too much to look forward perhaps to the pro- ction of an even more useful volume on selected ssified lines of the elements ?

The present volume includes data for the elements all known states of ionization. Indeed, more than ree-quarters of the book is devoted to highly nized atoms: this will appeal mainly to the ecialist; but the work has thus at least the merit completeness, and the inclusion of so much data s not apparently had any adverse effect on the ice, which is remarkably reasonable for these 309 ges of tabular matter.

A. G. GAYDON

e Human Body and its Functions

n Elementary Textbook of Physiology. By Prof. H. Best and Prof. N. B. Taylor. Revised edition. p. xi+500. (London: Chapman and Hall, Ltd., 49.) 18*s*. net.

THE names of Best and Taylor on any book on physiology give assurance that it will be author- tive and well written. The present volume is a vised edition of one aimed particularly at the yman rather than the medical student. Revision s enabled the authors to include some of the more cent advances in this science. In the account of roblems connected with safe blood transfusions, for xample, there is a note on the *Rh* factor, now recog- ized as the cause of certain hitherto unexplained o-natal deaths. The story of the vitamins is also rought up to date.

Part 1, on atoms and molecules and on protoplasm, hough simply written, may make difficult reading for those with no previous scientific training; but this should not deter the reader from passing on to the rest of the book, which will be easily understandable, helped by diagrams which on the whole are good but the value of which is sometimes lessened by over-simplification.

The interest of the book is enhanced by the inclusion in some of the sections of historical details. In the excellent account of respiration, for example, history is invoked to give an explanation of the double meanings we associate to-day with the words 'inspire', 'expire' and 'inspiration'. The whole book is a straightforward account of the functions of the human body. It is written in simple and clear language, and will undoubtedly entertain and instruct the lay reader, for whom it is intended.

W. C. C.

Catalogue of Union Periodicals

Vol. 1: Science and Technology Supplement. Edited by Percy Freer. Pp. 522. (Pretoria: South African Council for Scientific and Industrial Research, 1949.) n.p.

TO the "Catalogue of Union Periodicals. Volume 1: Science and Technology", issued in 1943 for the National Research Council and National Research Board, Johannesburg (see *Nature*, **154**, 102; 1944), a Supplement has now been issued. Again edited by P. Freer, librarian of the University of the Witwatersrand, it now includes entries relating to cement, paint, perfumery, soap and plastics, and is intended largely to replace the original 1943 volume. The new volume contains 4,758 main entries and 6,363 cross-references from 97 libraries, as against 7,175 main entries and 4,273 cross-references from 77 libraries in the original volume. New entries are distinguished by an asterisk and modifications in the arrangement, for example, one alphabetical sequence for all titles dealing with the same subject, in any one language, irrespective of country of origin, and the maintenance of a constant order for language sub-divisions were made in response to suggestions received. The abbreviations of the "World List of Scientific Periodicals" are again used.

Maintenance of Shade and Ornamental Trees

By P. P. Pirone. Second edition. Pp. xvii+436. (New York and London: Oxford University Press, 1948.) 32*s*. 6*d*. net.

THIS work, first published seven years ago, is a handbook for those concerned with the care of trees, and treats of many of the ills that the arboriculturist normally encounters, whether from faulty growth, pests or disease. The author is plant pathologist to the New York Botanical Garden and so writes from practical experience; the emphasis is naturally on American species and conditions, although the European grower will find much here that is useful, dealt with in simple language.

The present edition has been enlarged by a thirteen-page appendix in which brief notice is made of some of the newer insecticides such as D.D.T. and modern fungicides such as 'Fermate', as well as diseases that have assumed importance in recent years. But the most significant addition is a classified bibliography divided into sections corresponding to the various chapter subjects, which should be of considerable help to the public to whom this volume is addressed. The text is well illustrated by more than 170 figures, mostly photographic reproductions.

E. J. S.

NORWEGIAN-BRITISH-SWEDISH ANTARCTIC EXPEDITION, 1949-52

By DR. BRIAN ROBERTS
Scott Polar Research Institute, Cambridge

THE Norwegian–British–Swedish Antarctic Expedition, for which the necessary financial backing has been fully secured, left London on November 23, 1949, for the western part of Dronning Maud Land. The initiative for the project came from Prof. Hans W:son Ahlmann, of Stockholms Högskola, when, at a meeting of the Royal Geographical Society in November 1945, he proposed an expedition to undertake modern glaciological research in the Antarctic. Six months later, in May 1946, he proposed both in London and in Oslo that it should take the form of a joint Norwegian–British–Swedish expedition, and outlined the important results which might be expected from a detailed study of those areas in Dronning Maud Land which had been discovered and photographed from the air by the German *Schwabenland* expedition in 1939. The idea aroused wide interest in all three countries, but especially in Norway, where Norske Geografiske Selskab (Norwegian Geographical Society) set up a committee early in 1947, under the chairmanship of Generalmajor Hjalmar Riiser-Larsen, to make plans for an expedition to sail in the autumn of 1948. Riiser Larsen's plans, however, had to be abandoned at the beginning of 1948, owing to the difficulty of obtaining a vessel which could carry two Catalina aircraft, and the expense which the comprehensive programme of air survey would have involved. When Prof. H. U. Sverdrup was appointed director of Norsk Polarinstitutt in March 1948 he assumed responsibility, and under his direction a revised scheme was completed by May 1948.

Meanwhile, there had been considerable unofficial discussions in Norway, Sweden and the United Kingdom between those interested, and the Royal Geographical Society had advanced £2,000 from the Geographical Magazine Trust Fund to meet the initial expenses of a joint international expedition. A similar contribution, of Sw. Kr. 23,500, was made by Svenska Sallskapet för Anthropologi och Geografi (Swedish Geographical Society) in Stockholm. In June 1948 the Norwegian Storting approved the amended plans, and granted an initial sum of Kr. 200,000 (£10,000) for the preparations. In the following October the Norwegian Government extended a formal invitation to the Swedish and British Governments to participate in the expedition. It was proposed that three British and three Swedish scientific workers should take part, and that Norway, by reason of her territorial responsibilities in Dronning Maud Land, should provide the leadership and carry the main burden of the expense. This was estimated at a total of about Kr. 2,000,000 (£100,000); Sweden and the United Kingdom were each to contribute one-fifth, Kr. 400,000 (£20,000). In November 1948 the Swedish Government, and in December 1948 the British Government, accepted the Norwegian invitation. An international committee was set up. At an early stage it was agreed that financial liability should be vested in this committee and that Norsk Polarinstitutt should be the major guarantor, accepting any liability beyond the sums already promised by the United Kingdom, Sweden and the Norwegian Government. During the past year the preparations have been carried out by national committees in the three participating countries, with a central office at Norsk Polarinstitutt. The British committee, which includes representatives of Australia, New Zealand and South Africa, is known as the Joint Polar Committee, with the Royal Geographical Society and the Scott Polar Research Institute jointly responsible; there is also a small executive sub-committee. The work of organising the British participation has been centred in an office at the Royal Geographical Society.

During 1948 frequent meetings of the international committee took place. The members of the shore party were selected, and details of organisation were co-ordinated with the scientific programme.

The aim of this purely scientific expedition is to increase, primarily by geophysical methods, our knowledge of the ice, atmosphere and bare parts of the earth's crust, investigations which are of importance to a true understanding not only of local, but also of world-wide conditions. The most important object of the proposed work is to discover whether the recent climatic fluctuation, which has proved of such importance in the Arctic, is also taking place in the Antarctic. The programme is divided into three main parts: glaciology, for which Sweden is responsible; meteorology, for which Norway is responsible and geology, for which the United Kingdom is responsible. In addition, Norway is responsible for topographical survey, which is basic to all the other investigations.

A special study is planned of the physical properties of the inland ice. For this purpose it is hoped to record temperatures at different depths down to about 100 metres during a period of at least eighteen months by electrical resistance thermometers. It is hoped to obtain a knowledge of the crystallographic structure of the ice by drilling out an undisturbed core to a depth of about 150 metres with a U.G. Straitline boring machine from the Canadian Longyear Co., and to make a careful examination of the structure of the upper parts of the frozen firn in open shafts. Seismic equipment has been provided with the view of sounding a profile of ice thickness along a north–south line between the coast and the mountains. More specific investigations at the base will include determination of the amounts and different kinds of accumulation (direct precipitation and snow drift), and ablation quantity (melting, evaporation and wind corrosion).

The meteorological programme at the base includes regular standard observations on the ground, upper air investigations with *radio-sonde* and *rawin* apparatus, measurements of radiation, and detailed observations of temperature up to a height of 8 metres. A special investigation is also planned of the amount of snow carried by high winds. Arrangements have been made for wireless transmission of daily weather reports. Co-ordination with the weather services of South Africa, Argentina, Chile, the British Meteorological Office (for the Falkland Islands Dependencies Survey stations), the French expedition to Terre Adélie, and with ships in the whaling fleet will make possible a synoptic weather analysis on the expedition's return. Financial provision for this analysis has already been made by Norway.

The leader of the shore party is Captain John Giæver, of Norsk Polarinstitutt, who has had considerable experience in the Arctic. Although responsibility for the scientific work has been divided among the three countries, the scientific observers will work together in groups irrespective of their nationality. The composition of the shore party is as follows: J. Giæver, leader (Norwegian); E. F. Roots, senior geologist (British); V. Schytt, senior glaciologist (Swedish); N. J. Schumacher, senior meteorologist (Norwegian); B. Ekström, mechanic (Norwegian); G. H. Liljeqvist, assistant meteorologist (Swedish); P. Mellebye, wireless operator, in charge of dogs (Norwegian); S. Nilsen, cook (Norwegian); A. Reece, assistant geologist (British); G. de Q. Robin, physicist and radar expert (British); N. Roer, surveyor (Norwegian); E. Rogstad, wireless operator (Norwegian); C. W. J. Swithinbank, assistant glaciologist (British); and O. Wilson, medical officer (Swedish). Messrs. Reece and Robin are former members of the Falkland Islands Dependencies Survey.

A small R.A.F. unit will accompany the expedition for the southern summer of 1949–50. The unit consists of: Squadron-Leader G. B. Walford (in command), Flight-Lieutenant H. M. H. Tudor, Sergeant P. D. Weston, Corporal W. B. Gilbey, and Corporal L. A. Quar.

Two specially fitted Auster aircraft will be used for ice reconnaissance, to search for a suitable site for the base on the shelf ice, and for inland reconnaissance flights to facilitate the planning of later sledging journeys. One of these light one-engined machines, which have a flight radius of 120 miles, will be assembled on deck if the ship is held up by pack ice during her approach to the Antarctic mainland. It has been crated so that only the wings and a few controls require assembly. Both machines have been fitted with skis and will operate from the ice; but, if necessary, one of them can be fitted with floats to operate from the sea.

Official observers from Australia and South Africa will join the expedition at Cape Town and will accompany the ship during its first summer cruise. The Australian observer is P. G. Law, a physicist from the University of Melbourne, who was senior scientific officer on board the *Wyatt Earp* during her 1947–48 Antarctic voyage, and who is now the officer-in-charge of the Australian National Antarctic Research Expedition. The South African observer is J. A. King, chief of the Synoptic and Forecasting Branches of the Union Weather Bureau.

The co-operation of government departments and private firms in all three countries has been generous, and the Expedition is probably better equipped than any previous one which has sailed to the Antarctic. Each country has provided of its best, and when an item has not been available in Norway, Sweden or the United Kingdom, it has been obtained from other countries. The clothing and sledging equipment, in particular, includes examples of designs and materials which can be tested against each other with the view of resolving differences of opinion that have long been the subject of discussion. It is also expected that comparative trials of different techniques of travel and living in polar conditions will go far towards establishing their relative merits.

Both dog and mechanical transport have been provided. The sixty dogs include thirty from the Falkland Islands Dependencies, presented by Sir Miles Clifford, and thirty from East Greenland and Spitsbergen. [Fifteen of these dogs have died *en route* (see p. 20).] In addition, the expedition is taking three 'Weasels'.

Trials of equipment were undertaken at Kebnekajse in Sweden, in March and August 1949, and on Hardangerjökel in Norway, in April 1949.

The Norwegian Hvalfangerforeningen (Association of Whaling Companies) undertook to transport the three 'Weasels' and the sixty dogs to the Antarctic in the whaling factory ship *Thorshøvdi*, which left Sandefjord on October 26, 1949. The bulk of the 200 tons of stores have been loaded on the *Norsel*, which will rendezvous with the *Thorshøvdi* in the Antarctic early in January 1950, when the 'Weasels' and dogs will be transhipped. The *Norsel*, under the command of Captain G. Jacobsen, is a Norwegian sealer of 700 tons, which was completed at Flensburg during 1949. She was at Göteborg during October 31–November 2, at Oslo during November 3–17, and at London during November 3–23, collecting the members of the Expedition with their stores and equipment.

The *Norsel* reached Cape Town on December 20. It is hoped that the base on the Antarctic mainland will be established somewhere between long. 5° E. and 10° W. during February 1950.

This is the first international expedition to the Antarctic, and the experience which it will provide is likely to have considerable influence on the future planning of such international projects.

SCIENTIFIC CENTENARIES IN 1950

By Eng.-Capt. EDGAR C. SMITH, O.B.E., R.N.

THE earliest names in the list of men of science whose centenaries fall in 1950 are those of John Napier, of Merchiston, Scotland, who was born in 1550, and René Descartes, the French philosopher, mathematician and physicist, who died in 1650. The former is universally known as the discoverer of logarithms, while the latter is remembered for his "Discours de la Méthode" and other works, his theory of vortices and his invention of analytical geometry.

Thirty-six years ago, in 1914, Edinburgh celebrated the tercentenary of the publication by Napier of his "Mirifici Logarithmorum Canonis Descriptio", resulting in the preparation of the "Napier Tercentenary Memorial Volume", edited by C. G. Knott. On the occasion of the commemoration, the inaugural address was given by Lord Moulton. "The invention of logarithms," he said, "came on the world as a bolt from the blue. No previous work had led up to it; nothing had foreshadowed it or heralded its arrival. It stood isolated, breaking in upon human thought abruptly, without borrowing from other workers or following known lines of thought." As a youth Napier, who is sometimes referred to as the Laird of Merchiston, sometimes as the eighth baron of Merchiston, studied at St. Andrews and then travelled on the Continent. He was interested in farming, politics and theology, and published a commentary on the Apocalypse. After his first marriage, in 1572, he lived mainly at Merchiston Castle. His first son, Archibald, was raised to the peerage by Charles I, and it was from him that came the long line of notable naval and military commanders bearing the name. Napier died on April 4, 1617, and was buried in St. Cuthbert's Churchyard, Edinburgh. Two years before his death he was visited by Henry Briggs, whose life henceforth was devoted to the calculation of logarithmic tables, his "Arithmetica Logarithmica", published in 1634, containing the logarithms of 30,000 natural numbers to fourteen places of figures.

Like Napier, Descartes came of a noble family and was born on March 31, 1596, at La Haye Descartes, a small town in Touraine, now the department of Indre et Loire. Endowed with remarkable talents, as a boy he was taught by the Jesuits at the newly founded College at La Flèche, and as a youth in Paris he was friendly with Mydorge and Mersenne. For four years, 1617–21, he served first with Prince Maurice of Nassau and then with the Duke of Bavaria, and saw some of the fighting in the early part of the Thirty Years War. Then for seven years he worked and travelled in France, Switzerland and Italy, before settling in Holland, where he found himself free from irritating controversy. In 1649 he accepted an invitation from Queen Christina of Sweden to visit her at Stockholm. The colder climate unfortunately proved too much for him, and on February 11, 1650, when but fifty-three years of age, he died of inflammation of the lungs. His remains to-day lie in the church of St. Germain-des-Prés, Paris.

Cajori wrote, discussing the Cartesian theory of vortices: "After the overthrow of the Ptolemaic system and the rejection of the ancient crystalline spheres, the puzzle stared philosophers in the face, what is it that causes the planets to move in their orbits ? The answers given in Descartes's theory were eagerly accepted. All space is filled with a fluid, or ether, the parts of which act on each other and cause circular motion. Thus the fluid was formed into a multitude of vortices of different size, velocity and density. There is an immense vortex around the sun, carrying in its whirl the earth and the other planets. . . ." For the best part of a century the theory held sway, and it was the faith on which Newton was brought up. In France it was not dispelled until the middle of the eighteenth century. Voltaire, in his chapter headed "On Descartes and Sir Isaac Newton", in his "Letters on England" (1733), wrote: "A Frenchman who arrives in London, will find philosophy, like everything else, very much changed there. He had left the world a plenum, and he now finds it a vacuum. At Paris the universe is seen composed of vortices of subtile matter; but nothing like it is seen in England. In France it is the pressure of the moon that causes the tides; but in England it is the sea that gravitates towards the moon. . . . You will observe farther, that the sun, which in France is said to have nothing to do in the affair, comes in here for very near a quarter of its assistance. According to your Cartesians, everything is performed by an impulsion, of which we have very little notion; and according to Sir Isaac Newton, it is by an attraction, the cause of which is as much unknown to us. At Paris you imagine the earth is shaped like a melon, or of an oblique figure; at London it has an oblate one. . . . This famous Newton, this destroyer of the Cartesian system, died in March anno 1727. His countrymen honoured him in his life-time, and interred him as though he had been a king who had made his people happy."

To-day, not less defunct than the Cartesian theory, is the geological theory of Wernerism, due to the great German mineralogist, Abraham Gottlob Werner, who, according to some authorities, was born in 1749, and to others in 1750. For forty years Werner lectured and dogmatized at the Freiburg Mining Academy, Saxony, raising it to the importance of a university, and imparting his own enthusiasm to his listeners. Two passages from Sir Archibald Geikie's "The Founders of Geology" may interest: "His influence and fame sprang from the personality of the man. His unwearied enthusiasm and eager zeal in the furtherance of his favourite studies, his kindness and helpfulness, his wide range of knowledge, and the vivacity, perspicuity and eloquence with which he communicated it, his unbounded confidence in the solidity of his theoretical doctrines—these were the sources of his power rather than the originality and importance of his own contribution to geology." As for what Werner did for the science of the rocks, Geikie wrote: "As the results of my own investigation in this subject, I have been compelled to arrive at the conclusion that, although he did great service by the precision of his lithological characters and by his insistence on the doctrine of geological succession, yet that as regards geological theory, whether directly by his own teaching, or indirectly by the labours of his pupils and followers, much of his influence was disastrous to the higher interests of geology". Werner's life was placid enough until the advent of the Napoleonic Wars, and the distress due to these had something to do with his death at Dresden on June 30, 1817.

There could be no greater contrast in the lives of two men of science than that between the careers of Werner and his contemporary, Déodat Dolomieu. The son of "François de Gratet, chevalier, marquis de Dolomieu, comte de Saint Paul d'Izeau, seigneur de Tuelin, Saint-Didier-les-Champagnes et autres lieux, et de haute et puissante dame Marie-Françoise de Bérenger", Dieudonné-Sylvain-Guy-Tancrède, Gratet de Dolomieu, was born on June 23, 1750, at Dolomieu, near La Tour-du-Pin, in Dauphiny. Early made a member of the Order of Malta, he served in ships of the Maltese Navy, killed a comrade in a duel and was sentenced to imprisonment for life, only to be released after nine months. He then served several years in the French Army. From early days, however, he was devoted to chemistry and other sciences. Able to mix in any society, he travelled extensively, climbed the Alps, the Pyrennees, and the extinct volcanoes of Auvergne, knew Italy, Sicily and Portugal, published many books and papers and took part in the French Revolution. He became one of the first members of the Institut de France and held a post in the School of Mines at Paris. As one of the group of scientific men who accompanied Napoleon to Egypt, he was a member of the short-lived Institut d'Egypt. While sailing for home, his ship took refuge in Taranto and he was made a prisoner. In his cell at Messina, with ink made from lampblack, he covered with notes the margins of a geological work of Faujas de Saint-Fond. Many were the efforts made for his release, and in one letter Sir Joseph Banks, then president of the Royal Society, wrote to Lady Hamilton at Naples asking her to solicit the assistance of "the gallant Admiral". After the Battle of Marengo, Napoleon made it a condition of the armistice that Dolomieu should be liberated. In 1801 he returned in triumph to Paris and began lecturing at the Museum of Natural History. Shortly afterwards, he visited his sister at Châteauneuf in Charollais, only to die there on November 26, 1801, when about to undertake a journey to Saxony to see Werner. So came to a close a life of activity, adventure and hardship, a fascinating account of which was given by M. Alfred Lacroix to the Paris Academy of Sciences on December 2, 1918. Dolomieu's name is perpetuated by the useful magnesian limestone 'dolomite' and the range known as the Dolomites in the South Tyrol.

Passing from the men of science who laboured in the latter half of the eighteenth century to those whose work was done in the first half of the nineteenth century and who died a hundred years ago, the most important name is that of Joseph-Louis Gay-Lussac, one of the founders of modern chemistry. He was born on December 6, 1778, at St. Leonard in the department of Haute-Vienne, and from the days of his studentship at the Ecole Polytechnique his great abilities were recognized. He became especially celebrated for his numerous researches into the chemical and physical properties of gases and vapours. In 1804 he made two notable balloon ascents for scientific purposes, and in 1808 formulated Gay-Lussac's Law: When gases react together their volumes are simply related to one another and to the volumes of the products if these are gaseous. He lectured at the Ecole Polytechnique, the Sorbonne and the Jardin des Plantes, held government appointments, edited, with Arago, the *Annales de Chimie et de Physique*, in later years served as a deputy and in 1839 was raised to the peerage. He died in Paris on May 9, 1850. Forty years later, in August 1890, a statue of him was unveiled at Limoges. One of his contemporaries in England was Dr. William Prout (1785–1850), who, after taking his M.D. at Edinburgh in 1811, practised in London, lectured and experimented, and worked on the chemistry of the blood and the urine and of digestion. In 1815, in a memoir communicated to the Royal Society entitled "On the Relation between the Specific Gravity of Bodies in their Gaseous State to the Weight of their Atoms", he propounded the theory, known as "Prout's Hypothesis", that the atomic weights of all the elements are exact multiples of either the atomic weight of hydrogen or its half. His idea was widely discussed, being welcomed by some and rejected by others. It stimulated the exact determination of atomic weights, and later work has shown it to be remarkably near the truth.

Unlike any of the individuals already mentioned, William Sturgeon (1783–1850), the English electrician, started life with no advantages of birth or education. The son of a Lancashire shoemaker of no repute, and the apprentice of a worse, at nineteen he was a militia-man and at twenty-one a private in the Royal Artillery, and such he remained until his discharge on a pension of a shilling a day in 1820. But he was no ordinary private, for even in the barrack-rooms at Woolwich he gained a knowledge of mathematics, Latin and Greek, and at times amused the cadets of Woolwich Military Academy with his electrical experiments with kites. On his shilling a day he resumed boot-making, at the same time assisting to found a literary society and contributing to the *Philosophical Magazine*. Naturally, his zeal attracted attention, and in 1824 he was appointed a lecturer in science at the East India Company's Military Academy at Addiscombe, Surrey. In the following year he made history by presenting to the Society of Arts the first of all electromagnets with a soft iron core. It consisted of a horse-shoe of ½-inch bar iron about 12 inches long, wound with 18 turns of copper wire the ends of which dipped into cups of mercury. For this gift, since lost, the Society on May 21, 1825, awarded him the Silver Medal and thirty guineas. Just a century later, on May 20, 1925, Sir Ambrose Fleming read a paper to the same Society entitled "William Sturgeon and the Centenary of the Electromagnet", concluding with the remark that "Sturgeon's personal character, his high principles, blameless life, devotion to scientific truth and discovery, his genuine scientific achievements, as also his brave struggle against adverse fortune, brought him the respect and friendship of all good men". In 1840 Sturgeon returned to his native county, and he died at Prestwich, near Manchester, on December 4, 1850. For some years he had felt the pinch of poverty, only partially relieved by a small government grant.

The stories of the lives of such men as Dolomieu and Sturgeon stir the imagination and recall to mind the saying of Emerson, "I cannot even hear of personal vigour of any kind, great power of performance, without fresh resolution". Such is the effect of the story of Sidney Gilchrist Thomas, the young London police court clerk, who, working in his leisure, solved the important metallurgical problem of the dephosphorization of pig iron and so made possible the utilization of immense deposits of phosphoric iron ore hitherto considered useless. Born in London on April 16, 1850, he only lived to the age of thirty-four, and his early death, just when his discovery was being adopted all over the world, was partly due to the incessant demands on his mental and physical powers by the technical, financial and legal problems involved. The son of an Inland Revenue officer, he was educated at Dulwich School. His father's death in 1867 led to his abandoning all ideas of qualifying for a profession, and he obtained a clerkship in the Marlborough Street Police Court, from which he was transferred to the Thames Police Court, Stepney, After making himself competent in his duties, he took up the study of chemistry and physics, and it was a chance observation by a lecturer at Birkbeck College which turned his attention to the pig-iron problem. How he was assisted, first by his cousin, Percy Carlyle Gilchrist (1851–1935), F.R.S., then by Edward Pritchard Martin (1844–1910), Edward Windsor Richards (1831–1921) and John Edward Stead (1851–1923), F.R.S., will no doubt be told by Mr. James Mitchell at the commemoration of Thomas's centenary by the Iron and Steel Institute on April 26. Suffice it to say here that the success of the Thomas–Gilchrist process lay in the discovery of lining the melting furnaces with the mineral dolomite, and so the name of a pioneer in metallurgy is linked with that of a worker in the Heroic Age of geology. Thomas's death took place in Paris on February 1, 1885, and he was buried in the small cemetery at Passy. No country benefited more from Thomas's work than France, and on December 5, 1932, a special meeting of the Société des Ingénieurs Civils de France was held to commemorate the jubilee of the introduction of the Thomas–Gilchrist process. The meeting was attended by the President of the Republic, M. A. Lebrun, and addresses were given by Prof. A. Portevin, Dr. Léon Guillet and others. Many figures have been given showing the growth of the basic steel industry, and on this occasion it was stated that of 9,447,000 tons of steel produced in France in 1930, 98 per cent had been manufactured by the basic process, while 1,478,000 tons of phosphate slag had been marketed. Even when ill and living for a time in Algiers, Thomas had experimented with basic slag as an artificial fertilizer, thus placing agriculturists, as well as engineers, in his debt. In the history of discovery and invention, the story of Thomas is unique.

SELECTIVE TOXICITY*

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SELECTIVE toxicity may be defined as the science of injuring certain kinds of living cells without harming other kinds of cells in the vicinity. In practice, selective toxicity is used to injure uneconomic cells so as to favour survival of the economic cells with which they are associated. These uneconomic and economic cells may be related to one another as parasite and host, or they may be purely commensal.

Although a great deal of the research undertaken in this field has been empirical in character, there is an ever-increasing interest in attempts to develop the subject on a rational basis. Progress towards this end is important in facilitating teaching and in bringing a heightened sense of order to academic research. In addition, it has great potential value for the development of the applied side of the subject.

Some of the applications of selective toxicity have been strikingly successful. By the use of selectively toxic agents, the farmer has greatly increased his yield per acre because he has been able to suppress many fungi, weeds and insects which used to threaten his crops. It is a remarkable achievement to have discovered such selectively toxic agents as phenylmercuric nitrate for fungicidal seed-dressings, methylchlorophenoxy-acetic acid as a weed-killer and D.D.T. as an insecticide ; these have materially aided agriculture by removing uneconomic forms of life, to the great benefit of the economic forms.

In animal husbandry, too, selectively toxic agents have greatly increased the productivity of man's economic animals by controlling many kinds of noxious parasites, both external and internal. Man himself, who is no less subject to infection than his economic animals, has also benefited directly. The special branch of selective toxicity that is concerned with the removal of parasitic organisms from man and his tended animals is known as 'chemotherapy'.

Selective toxicity has also been introduced into the much more complex situation where both economic and uneconomic cells form part of the same organism. This branch of the subject is known as 'pharmacology'. By pharmacological means it is often possible temporarily to suppress a natural function, such as the sensation of pain. An all-or-nothing effect will not serve, because a graduated response is required. This must be followed eventually by a complete reversal of the inhibition, because an anæsthetized patient does not expect to be deprived of feeling for the remainder of his life. Difficult as are the problems set by pharmacology, many selectively toxic agents have been discovered for use in this domain, some of them outstandingly effective.

Such achievements are remarkable and praiseworthy, but there are still many economic problems in selective toxicity awaiting solution. It is reasonable to believe that these problems will be more easily solved when (*a*) attention is closely focused on such connexions between constitution and activity as have been reliably established, and (*b*) when the search for underlying principles becomes intensified.

Scientific Basis for Selective Toxicity

In some cases the basis of selective toxicity is simply a differential accumulation of the toxic substance. For example, a 20 per cent solution of sulphuric acid is still considered the best agent for removing chickweed from a wheat crop[1]. Although sulphuric acid is just as injurious to the cytoplasm of wheat as it is to that of chickweed, the weed is rough and the wheat-plant is smooth, so that the acid accumulates on the chickweed but is shed from the wheat.

However, in many cases, accumulation seems to play a comparatively minor part. For example, the powerful œstrogenic drug 'Fenocyclin' is concentrated respectively 7 and 2·5 times more strongly in the intestines and liver than in the uterus, although it acts only on the last-named[2]. Many similar examples induce us to believe that a strong, localized biological action depends on a high degree of chemical specificity. This means a reaction that cannot take place to anything like the same extent in other than the affected cells.

This raises what seems, at first, a formidable difficulty : How can it be possible for toxic agents to act selectively on different types of cell when, as the major biochemical discoveries of the last decades have indicated, there is a common ground-plan for all living matter whether animal, vegetable or microbiological ? For example, the Meyerhof sequence of glycolysis has been found in bacteria, Protozoa, worms, insects, echinoderms and vertebrates as well as in yeasts and the higher plants. There is no essential difference between the glycolysis of such a lowly form of life as yeast and some of the most highly organised tissues such as human muscle and liver. Moreover, it is well known that some vertebrate hormones can act on invertebrates and *vice versa*, and that the vitamins which are essential for man are also required by many bacteria (thiamine, riboflavine and nicotinic acid are apparently essential constituents of all living cells).

Remarkable as those similarities are, the very fact that one species behaves differently, and looks different, from another species is in itself a demonstration that marked biochemical dissimilarities exist. For the same reason there must be marked biochemical variations between different tissues of the one organism. For example, although the Meyerhof sequence of glycolysis is widely used in Nature, certain bacteria, yeast and fungi appear to be able to oxidize glucose directly and others oxidize glucose-6-phosphate directly. These methods, which are probably evolutionary relics, avoid the formation of pyruvic acid. Even where various species carry out identical biochemical tasks in glycolysis, identical enzymes are not always involved. For example, the alcohol-oxidase present in liver does not contain the active thiol groups present in the alcohol-oxidase of yeast[3].

The requirements for trace-metals also vary enormously from species to species. Take, for example, a need for molybdenum shown by nitrogen-fixing bacteria, for gallium in the case of the common mould *Aspergillus niger*[4] and the accumulation of vanadium by common protochordates. In short, a qualitative basis for selective toxicity plainly exists.

Even when similar metabolic pathways are used by two species, quantitative differences become apparent. Pathogenic trypanosomes, for example, utilize glucose two thousand times faster than their hosts[5]. Their carbohydrate metabolism is more wasteful and more vulnerable than ours.

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* Based on a series of eight public lectures given in the Biochemistry Department, University College, London, during the spring of 1949.

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From these considerations it follows that *comparative biochemistry* is a branch of science which holds the key position for the logical discovery of selectively toxic agents. Unfortunately, little effort has been made to attract workers to this field, and little help can be expected from this quarter until more vigorous steps are taken. At present, comparative biochemistry tends more often to follow than to precede the discovery of a selectively toxic agent. For example, after the discovery of penicillin, it was found that this drug prevents the absorption of glutamic acid by those bacteria which it injures most. It was then found that these bacteria (for example, Staphylococci) are dependent upon an external source of glutamic acid, whereas human tissues and the types of bacteria which are least susceptible to penicillin are capable of synthesizing their own requirements of this acid[6].

Physical and Chemical Properties

From the point of view of present-day knowledge of the chemical bond, it is idle to classify selectively toxic agents into those that act by chemical means and those the action of which is physical. The term 'chemical reaction' is no longer restricted to the making and breaking of ionic and covalent bonds, because hydrogen bonds, ion-dipole bonds and multiple van der Waals bonds are known often to involve quite comparable amounts of energy. As Langmuir pointed out, even so simple an operation as the warming of water is actually a chemical depolymerization. Hence it is to be expected that the action of selectively toxic agents should often involve bonds which are neither covalent nor ionic.

The action of the greater number of selectively toxic agents depends on considerable specificity of structure. Such substances need to have particular molecular shapes with certain groups at particular distances. These conditions apparently enable combination with specific cell constituents to take place.

However, there is one class of agent which depends on certain physical properties making for accumulation. Such substances may be hydrocarbons, chlorinated hydrocarbons, alcohols, ethers, ketones, non-ionized bases (for example, aniline) or non-ionized acids (particularly phenols and barbiturates). These *structurally non-specific agents* are hypnotics for man (general anæsthetics if sufficiently volatile) and mild but effective poisons for insects. Their action apparently depends on their accumulating at some vitally important part of the affected cell where, for no other reason than that they are foreign bodies, the chain of respiratory processes becomes disorganised. Ferguson[7] has shown that all these substances have the same degree of biological action *when present at the same proportional saturation*. As an example of this principle, Ferguson cited the effect on the wireworm of various hydrocarbons and halogenated paraffins applied as vapours diluted with air. When equimolecular concentrations were compared, a 4,000-fold variation in activity was found. But when the substances were compared at the same proportional saturation (for example, by calculating the fraction of the saturated vapour pressure required to kill), a reasonably constant figure (0·5) was obtained. That is to say, these substances are equitoxic when air is half saturated with any one of them. Different constants are obtained for different kinds of biological result.

Structural Specificity

When, as is usually the case, toxic agents are structurally specific, it is not uncommon to find that the degree of specificity is indeed high. For example, only two (out of the possible five) monoaminoacridines are antibacterial, and only one of the three aminobenzenesulphonamides and one of the seven mono-hydroxyquinolines. Sometimes the presence or absence of an apparently chemically inert group makes all the difference between inactivity and a high degree of activity. Methyl groups are typical of those substituents which can profoundly increase biological activity without themselves forming new covalent linkages. There are four pathways through which this effect can operate. First, the insertion of a methyl group alters solubility; sometimes, surprisingly enough, the solubility in water is increased. Secondly, the oxidation-reduction potential is lowered through the inductive effect of the methyl group. Thirdly, similar inductive effects influence the ionization, thus weakening acids and strengthening bases. Fourthly, the molecule is changed in a steric sense and can make a better or worse fit on a vital biological surface (for example, an enzyme).

The importance of this fourth pathway is most clearly shown in the metabolite analogues, substances which are made chemically and sterically similar to some important cellular metabolite. If the resemblance is considerable, and yet not too great, the analogue usually has the effect of blocking the natural receptors for the metabolite, which then can no longer exert its proper biological action. Usually, the blocking action of the analogue can be reversed by an excess of the metabolite. Perhaps the most familiar example of a metabolite analogue is malonic acid, which competitively inhibits the enzyme succinic dehydrogenase because it displaces the normal substrate (succinic acid). Because succinic dehydrogenase is important in the metabolism of plants and the higher animals, malonic acid is of no use as a selectively toxic agent. However, Fildes and Woods showed in 1940 [8,9] that sulphanilamide is antibacterial because it is a metabolite analogue of *p*-aminobenzoic acid, which is a substance of particular importance in bacterial metabolism. Woolley[10] lists forty metabolites (mainly vitamins and amino-acids) for which antagonistic analogues are known. In two cases, valuable drugs have been evolved directly from theoretical considerations of this kind.

One of these drugs is B.A.L. (British Anti-Lewisite), which is a selectively anti-toxic agent of great value in cases of chronic arsenical and metallic poisoning in man. The story of the rational steps which led to its discovery makes interesting reading[11]. The other drug is phenyl-pantothenone. When it was found that pantothenic acid greatly increased the survival time of malarial parasites *in vitro*[12] and hence was presumably an important natural metabolite, various analogous substances were tested as antimalarials. The best of these, phenyl-pantothenone, was found to be at least as effective as quinine in man[13]. Because of the commercial availability of 'Mepacrine', over which phenyl-pantothenone showed no special advantage, the new drug was not marketed. This does not in any way detract from the magnitude of the achievement.

Many other metabolite analogues are used in medicine and agriculture, although they were not discovered by planned experiments along the above lines. The possibilities of finding new selectively toxic agents by making analogues of known metabolites are considerable. Nevertheless, this procedure is not so simple as was at first thought, because special considerations of distribution arise.

Ionization

Among the various factors responsible for the action of selectively toxic agents, ionization phenomena must be accorded an important place. Many toxic substances are capable of ionization, and many of them are ionized to different degrees with small changes in *p*H. Conversely, at a given *p*H value, members of a series of substances, almost identical in chemical structure, usually are ionized to quite different degrees. These facts would be unimportant if both the ion and the neutral molecule of a given substance had the same biological action. But in all cases that have been investigated, they behave quite differently. These differences are quantitatively significant and often partake of an all-or-nothing character. In those cases where the ion is the more toxic, it might be thought that even a poorly ionized substance would produce a few ions and that as these are removed by the receptors of the cell fresh ions would be generated from the neutral molecules according to the mass action law. So far, all experimental evidence contradicts this assumption, any deficiency of ions in the solution being replaced not only from the neutral molecules but also from the complex which the ions form with the cellular receptors. These complexes are reversible, as is shown, for example, by crystal violet, which ceases to be bacteriostatic for *B. coli* at a dilution of 1 : 20,000, although the solution is intensely violet and still has many of the lethal cations present.

The acridine antibacterials present the most completely explored example of a positive correlation between ionization and biological activity[14]. In a series of a hundred and seven acridines of all kinds, those examples which were more than 50 per cent ionized at *p*H 7 proved to be highly antibacterial, whereas those which were poorly ionized showed little or no antibacterial action. It was shown, further, that the ionization must be cationic in type to be effective, anionic and zwitterionic examples being ineffective. It was further shown, by working in buffered media, that competition takes place between acridine cations and hydrogen ions, in a simple ratio, so that the acridine ions become increasingly more effective as the medium is made more alkaline (up to the point where alkalinity causes repression of ionization, as it can with the weaker bases). The simplest interpretation of these results is that acridine cations successfully compete with hydrogen ions for a vitally important anionic group (on the bacterium) and thus block it. It has been calculated from the data that such a group must have a pK_a of 9 or higher. Hence it could be a hydroxyl-group in the purine constituents of a nucleic acid.

More recently, it has been shown that in seven other families of heterocyclic bases, antibacterial action is proportional to ionization, and that this correlation can be extended to the smaller benzologues (pyridine and quinoline) so long as their molecules are substituted so as to provide the same area of flat surface as is provided by, say, acridine, phenanthridine or the benzquinolines[15].

On the other hand, the biological action of weak aliphatic and aromatic acids, of barbiturates and of bases having local anæsthetic action is more closely linked with the neutral molecule than with the ion. This effect was first noticed in 1921, when the antibacterial action of benzoic acid was investigated at various *p*H values[16]. It has since been shown that all members of a series of thirty barbiturates enter both eggs and larvæ of the sea-urchin exclusively as neutral molecules and that the resulting depression of cell-division and respiration, respectively, is also due exclusively to neutral molecules[17].

Binding of Trace Metals

Traces of various heavy metals have been shown to be essential for life. Some of the more bizarre examples have already been mentioned : more widely required metallic ions include copper, cobalt, zinc, manganese and iron. These substances are toxic in excess. Hence, it is evident that a selectively toxic action could be exerted by increasing the concentration of a metallic ion above the tolerance limit for the uneconomic cell, provided that this is below the tolerance limit for the economic cell. Conversely, a similar result could be obtained by reducing the concentration of a metallic ion below the minimum compatible with the life of the uneconomic cell, provided that the concentration in the economic cell did not fall below its minimal value.

So far, the exploration of those possibilities has scarcely begun, but the trace metal requirements of various cells is so different, quantitatively and qualitatively, as to encourage this approach to the discovery of new selectively toxic substances. These substances would have to be complexing agents, that is to say, they would have to be constructed so that they formed complexes with metallic ions, complexes so stable that they were in equilibria with only the minutest amounts of these ions (say 10^{-12} or less). It will not be forgotten that in Nature the metals are held by similar chelating agents such as the pteridines and amino-acids, so that the would-be toxic agent must compete with these for the metals. This competition is more likely to be successful if the new complex has a higher stability constant than the old in the equilibrium :

$$K = \frac{[\text{complex}]}{[\text{complexing agent}]^n[\text{metal ion}]}.$$

These constants can be readily determined by potentiometric titrations[18]. Researches of this kind will be greatly advanced when it becomes possible to design complexing agents that will be specific for particular metals under physiological conditions. (Unfortunately, the specificity of the analyst's spot-test reagents usually depends on boiling the solution or on the use of strong alkalis or acids.) The great majority of known complexing agents combine powerfully with copper and less powerfully (in this order) with cobalt, zinc, iron, manganese and magnesium. However, at least two substances are known which combine exclusively with iron, under physiological conditions, namely, α : α-dipyridyl and *o*-phenanthroline[19], and other examples of this type should be sought.

8-Hydroxyquinoline, which has been used clinically for fifty years as a powerful local antibacterial agent, has recently been shown to function by chelating one or more trace-metals in bacteria[20]. The six isomeric mono-hydroxyquinolines do not chelate and are not antibacterial. On the other hand, various heterocyclic nuclei can be made just as effective against bacteria as 8-hydroxyquinoline is, by providing them with the same chelating mechanism, namely, a hydroxyl-group *peri* to the ring nitrogen. Thus 8-hydroxy-5 : 6-benzquinoline and 6-hydroxy-*m*-phenanthroline are equal to 8-hydroxyquinoline both in chelating power and in antibacterial activity. The chelating and the antibacterial properties both disappear if either the nitrogen or oxygen atom is methylated. Antibacterial activity fails to run parallel to chelating power only when groups are introduced into the molecule which prevent the metallic complex from being lipo-soluble. For example, 8-hydroxyquinoline-5-sulphonic acid and 4-hydroxypteridine are strong chelating agents, but their metallic complexes are water-soluble instead of being lipo-soluble. This factor seems to be of vital importance in the action of this class of compound, and it would seem that penetration of a cytoplasmic membrane plays an important part in their action.

The biologically important heavy metals with which 8-hydroxyquinoline chelates at *p*H 7 are: copper, cobalt, zinc, iron and manganese, and it is not yet clear with which of these its rapid bactericidal action is mostly connected. There is little doubt that, in the case of *Staphylococcus aureus*, iron (Fe^{++}) is the metal principally concerned[21]. In this case, the lethal action of the drug seems to be concerned with transporting iron (with which it combines relatively weakly) through the protoplasmic membrane, with the result that ferrous iron becomes present in toxic concentrations inside the cell.

The Covalent Bond

So far we have been able to discuss many important aspects of selective toxicity without more than a passing reference to the covalent bond. It is difficult for the organic chemist, who spends so much of his time making and breaking covalent bonds, to realize what a relatively unimportant part they seem to play in the action of selectively toxic agents. It is true that we know of a few drugs which do not exert their action until they are chemically altered by the body; but the list is a short one. A typical drug of this class is the sulphonamido-azobenzene 'Prontosil', which functions in the body only after it has been reduced to sulphanilamide. However, it has been found preferable to administer sulphanilamide as such. Again, pentavalent arsenicals are known to act against spirochætes and trypanosomes only after reduction to the trivalent form; but in the treatment of syphilis it has been found better to use trivalent arsenic directly. It is only when the organisms have penetrated into the central nervous system (whither trivalent arsenicals diffuse only slowly) that pentavalent arsenicals are found useful, because they penetrate well and then liberate trivalent arsenic where it is required.

Apart from such harnessing of the covalent bond to convey the drug to the site of action (or to retard its absorption), only rarely has it been shown to constitute the toxicity-determining linkage between the drug and vital cellular constituents. The reason may be that those toxic agents the affinity of which for cellular-receptors is tempered by a measure of reversibility are the more likely to show true selectivity, particularly where they are attacking chemical groups common to both the economic and the uneconomic cells. The reversibility of the action of selectively toxic agents when the experimental conditions are changed is a very well-known biological phenomenon. Such reversibility would not be expected, if covalent bonds are concerned, because of their high energy (40–100 k.cal. per gm. mol.) at 37° C., or lower.

Only in the case of arsenical drugs has the mode of action been traced to covalent-bond formation. Here the biologically effective reaction is believed to be:

$$R\text{—As}{=}\text{O} + 2R'\text{—SH} \rightleftharpoons R\text{—As}(\text{S}R')_2 + \text{H}_2\text{O}.$$

The As—S linkage has an abnormally low bond-energy and the reaction can be shown, *in vitro*, to go practically to completion in either direction at room temperature, depending on which substance is in excess. The formulation of the above mode of action of arsenical drugs (that is, combination with biologically important thiol-groups) was first suspected by Ehrlich[22] and placed on a reasonably secure basis by Voegtlin and his co-workers[23–26].

Some Landmarks in Chemotherapy

All branches of selective toxicity should benefit from consideration of the theoretical foundations of chemotherapy, which are better established than those of other sections of the subject.

Guided by his studies on the differential staining of living cells, Ehrlich decided, about 1899, to synthesize substances of low molecular weight which would attack (internal) parasites directly and leave the host unharmed. In 1904 he succeeded in curing trypanosomiasis in mice with Trypan Red (a synthetic chemical of low molecular weight), thus originating the first man made chemotherapeutic agent. This conception that effective drugs would have relatively low molecular weights has been well substantiated, the majority of chemotherapeutic agents in current use having values between 170 and 600. This forms a contrast with the protective agents (antibodies) of immunotherapy (by sera and vaccines) which have molecular weights of at least 200,000.

Ehrlich's principal contention, that chemotherapeutic drugs act by a direct combination between their chemically active groups and other chemically active groups (called receptors) in the parasites, provoked much opposition. Many agreed with Uhlenhuth[27] that the drugs had no such direct action on the parasite, but worked by stimulating the natural resistance of the host. Others conceded that the drugs might act upon the parasite, but only after they had been chemically altered by the host[28].

The experimental evidence for testing these various hypotheses came nearly twenty years after Ehrlich's death in 1915. It was then shown[29] that normal trypanosomes, when treated with a solution of a trivalent arsenical, were rapidly killed, and the solution would not kill fresh trypanosomes. Hence it is possible to titrate the trypanosomes against the arsenical and thus calculate the number of chemoreceptor-groups which they contain. Clearly, susceptible strains of parasites possess groups with which they combine with the drug and so remove it from solution. On the other hand, when arsenic-resistant trypanosomes are treated with a trivalent arsenical, they are not killed and the residual solution will still kill susceptible trypanosomes.

About this time it was shown that the bodies of the killed parasites contain considerable amounts of arsenic, whereas the resistant parasites contained none[30]. Advances in technique made it possible to demonstrate fixation of a drug by parasites while they were circulating in the host's blood stream. This was done, in turn, for 'Trypaflavin', antimony, gold and arsenic[31,32,33].

Ehrlich had always maintained that a drug needs two active groups, one to assist its uptake by the parasite and another to combine with a vitally active group in the parasite. Hence it follows that the mere uptake of a foreign substance need not be harmful to an organism. This was neatly demonstrated in 1935 when it was shown that malarial parasites and trypanosomes take up the three acridines, 'Atebrin', 'Trypaflavin' and 'Rivanol', but that the 'Atebrin' harms only the malarial parasites, the 'Trypaflavin' only the trypanosomes and the 'Rivanol' injured neither[34].

It is now generally agreed that the action of chemotherapeutic drugs is directly on the parasite, that their reaction with the parasite is chemical in nature and that there are two distinct reacting groups in many of the most active drugs. The co-operation of the natural defence factors of the body is also recognized. These factors, among them the reticulo-endothelial system[35,36], are believed to cope with the parasite once the drug has disorganised the latter's metabolism. The suggestion that some of Ehrlich's chemoreceptors are located in vitally important enzyme-systems[8] is one of the most stimulating suggestions made in recent years.

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OBITUARIES

Mr. John H. Reynolds

By the death of Mr. John H. Reynolds, British astronomy loses one of that long succession of amateurs who have contributed so much to the advance of the science they loved. In this case astronomical work in other countries has also been promoted by generous gifts. Early in this century, Mr. Reynolds secured a 30-in. Common mirror for his own use; but a visit to Egypt convinced him that more value could be obtained from his mirror if it were installed there than in his own garden. So an offer of a 30-in. reflecting telescope, with a mounting designed by Mr. Reynolds, was accepted for the Egyptian Government by Capt. H. G. Lyons, R.E. (later Sir Henry Lyons), of the Survey Department. A dome near Helwan was available, and the telescope began work on nebular photography in 1907. On the return of Halley's comet in 1910, the first photograph of it was secured at Helwan by Dr. Knox Shaw. Later, Mr. Reynolds installed a 28-in. reflector with the same type of mounting at his home in Harborne, where he began work in 1911. The 30-in. mirror was brought back from Helwan in 1923 to Birmingham. The second telescope was later presented to the Commonwealth Observatory on Mt. Stromlo, Canberra, where it is once more in full use in a photometric programme.

Mr. Reynolds's chief interest over many years was in nebular astronomy, particularly the extra-galactic nebulæ. He studied them in monochromatic light and in polarized light, examining their spiral forms, the distribution of condensations within them and their stellar development from type to type. He also examined them photometrically for internal light distribution. He obtained his material partly in Birmingham and partly at Helwan, for he maintained a close connexion with this Observatory from its start. He joined two eclipse expeditions, to Algiers and Egypt. He served for many years on the Council of the Royal Astronomical Society, mainly as treasurer; he was president during 1935–37. The University of Birmingham gave him the honorary degree of M.Sc. in recognition of his work for astronomy.

In addition to his normal business activities, Mr. Reynolds had other interests, being an accomplished musician. For some years he was honorary secretary of the Midland Institute, Birmingham, taking great interest in securing lecturers for it. He died on November 22, aged seventy-five, having collapsed at the close of a meeting where he had just taken part in the discussion of an astronomical lecture, showing that he maintained an active interest in astronomy right to the end of his life. F. J. M. Stratton

Mr. J. F. Marshall, C.B.E.

John Frederick Marshall, who died on December 5, at the age of seventy-five, was a leading authority on British mosquitoes. Son of the late Charles Marshall of Huntingdon, he was educated at Rugby and King's College, Cambridge, where he took a first class in the Mechanical Sciences Tripos, Part 1, in 1896, and in Part 2 (with special distinction) in 1898, and was called to the Bar, Inner Temple, in 1902.

Marshall first became actively interested in British mosquitoes about 1920 when, owing to their great prevalence in the neighbourhood of his home at

"Seacourt", Hayling Island, he organised a control scheme in 1921 after consultations with the late Dr. F. W. Edwards, of the British Museum (Natural History), and the late Colonel S. P. James, of the Ministry of Health. Marshall built, equipped and directed, at his own expense, the British Mosquito Control Institute in the grounds of his house on Hayling Island, which was officially opened by the late Sir Ronald Ross in 1925. This Institute is a centre for both pure and applied research upon mosquitoes, and has been visited by fellow-workers from all over the world.

Although some seventeen species of mosquitoes were recorded by Marshall as occurring on Hayling Island, the species which at times made life on the Island well-nigh unbearable was the brackish-water breeder *Aedes detritus* and, to a lesser extent, *Aedes caspius*. It was natural that Marshall should concentrate on a study of these two troublesome species, and his numerous publications show clearly with what meticulous care and accuracy he worked out their biology and bionomics. With his knowledge of mathematics he devoted much time, care and skill to insect photography, and invented a new apparatus for photographing insects, which he described in the *Bulletin of Entomological Research*. His greatest achievement, however, and the one which will for ever be associated with his name, is his book entitled "British Mosquitoes", which was published by the Trustees of the British Museum (Natural History) in 1938. It was the successor of Dr. W. D. Lang's "Handbook of British Mosquitoes" (1920). Marshall described nine species of mosquitoes not mentioned in Lang's book and also filled in numerous gaps in our knowledge concerning many species of which, although they were recorded as indigenous, very little was known. He added to our knowledge of their breeding-places, their bionomics and the means of classifying their larvæ, particularly the early instars. His book contains 172 text figures and twenty-five other drawings or photographs, most of which he did himself with the help of his enthusiastic assistant, Mr. J. Staley, and which bear testimony to the photographic apparatus which he invented. He was awarded the C.B.E. in 1936.

Between 1921 and 1925, I worked with Marshall while the mosquito survey of Hayling Island and the surrounding district was being made. The realization that the control measures necessary for success were both difficult and complicated stimulated Marshall and added an interest to this branch of the work which never flagged.

Marshall married in 1902 Blanche Gray, who survives him. She supported and helped him in all his scientific activities. Their daughter, Joan Grant (Mrs. Charles Beatty), is the talented author of "Winged Pharaoh" and other widely read literary works.

P. G. SHUTE

WE regret to announce the following deaths:

Dr. Clifford Dobell, F.R.S., protistologist to the Medical Research Council, on December 23, aged sixty-three.

Prof. W. H. Newton, professor of physiology in the University of Edinburgh, on December 20, aged forty-five.

NEWS and VIEWS

New Year Honours List

THE following names of men of science and others associated with scientific work appear in the New Year honours list:

Baron: Dr. L. Haden Guest, M.P., secretary of the Leverhulme Research Fellowship Committee, for political and public services.

K.B.E.: F. Brundrett, chief of the Royal Naval Scientific Service; H. C. Papworth, vice-chancellor of the University of Travancore.

D.B.E.: Prof. Olive Wheeler, professor of education and dean of the Faculty of Education in University College, Cardiff.

Knights: Prof. A. L. Bowley, during 1919–36 professor of statistics in the University of London; A. M. Bryan, chief inspector of mines, Ministry of Fuel and Power; Philip Hendy, director of the National Gallery; Dr. A. W. Pickard-Cambridge, deputy chairman of the Public Schools' Governing Bodies Association, during 1930–38 vice-chancellor of the University of Sheffield; S. J. Saint, director of agriculture, Barbados; Arthur Sims, for services to medicine and education in the British Commonwealth; Prof. A. G. Tansley, chairman of the Nature Conservancy; Dr. W. W. D. Thomson, professor of medicine, Queen's University, Belfast; Prof. R. L. Turner, director of the School of Oriental and African Studies, University of London.

C.B.: A. H. Gosling, director-general of the Forestry Commission; S. S. Hall, director-general of technical development (air), Ministry of Supply; Dr. O. H. Wansbrough-Jones, scientific adviser to the Army Council.

C.M.G.: A. B. Killick, director of agriculture, Uganda; W. H. Cocker, of Auckland, New Zealand, for outstanding services in university administration and adult education.

C.B.E.: J. Anderson, chief scientist, H.M. Underwater Detection Establishment, Portland; Mehmed Aziz, executive officer, Anopheles Eradication Scheme, Cyprus; O. G. S. Crawford, archæologist; H. W. Dawes, president of the Royal College of Veterinary Surgeons; A. N. Duckham, agricultural attaché at the British Embassy at Washington; Prof. F. Hardy, professor of chemistry and soil science, Imperial College of Tropical Agriculture, Trinidad; C. Harvey, director of agriculture, Fiji; Dr. Franklin Kidd, director of food investigation, Department of Scientific and Industrial Research; E. C. Lloyd, deputy chief veterinary officer, Ministry of Agriculture; Miss Ida C. Mann, senior surgeon, Royal London Ophthalmic (Moorfields) Hospital; Prof. J. W. Munro, professor of zoology and applied entomology in the Imperial College of Science and Technology, London; F. M. Owner, chief engineer (Engine Division), Bristol Aeroplane Co., Ltd.; Prof. F. G. Soper, professor of chemistry in the University of Otago, for public services; W. J. Spafford, lately director of agriculture, South Australia; K. T. Spencer, deputy director of aircraft research and development (technical), Ministry of Supply; Prof. A. M. Tyndall, chairman of the Executive Committee, National Physical Laboratory.

Military College of Science :

Prof. A. Porter

Prof. Arthur Porter, professor of instrument technology in the Military College of Science, Shrivenham, has left to take up the post of director of research in the Canadian branch of Ferranti, Ltd. Prof. Porter is a graduate of the University of Manchester. During the period 1933–37 he worked under the direction of Prof. D. R. Hartree on the development and application of the Manchester differential analyser. This machine, which was the first of its kind to be built outside the United States, was applied to a wide variety of problems ranging from the determination of atomic wave functions by the method of self-consistent fields on one hand, to the study of non-linear electrical networks and terminated transmission lines on the other. After serving as assistant lecturer in physics during 1936–37, Dr. Porter obtained a Commonwealth Fund Fellowship and worked under Dr. Vannevar Bush at the Massachusetts Institute of Technology during 1937–39 on the development of the 30-integrator Rockefeller differential analyser. During the Second World War he worked in various government research establishments, including the Admiralty Research Laboratory, the Army Operations Research Group, and the Radar Research and Development Establishment, on anti-aircraft fire control and related problems. His main interest was the study of automatic and manual control systems and their application in military and industrial instruments and processes. He was secretary of the Ministry of Supply Servo Panel during its existence (1942–45), and he was also the secretary of the Interdepartmental Technical Committee on Servo Mechanisms from its inception in 1944. In May 1946 he joined the National Physical Laboratory and started a new section on automatic control problems, with particular reference to industrial applications. Porter joined the Military College of Science in October 1946, to be the first occupant of the new chair of instrument technology, and immediately threw himself into the very considerable task of organising courses in instrument technology and engineering physics and in establishing laboratories for these new subjects. While the courses and laboratories are not yet in a settled state, they do represent a very fine achievement for so short a time.

Mr. C. Holt Smith

Mr. C. Holt Smith has been appointed professor of instrument technology at the Military College of Science in succession to Prof. A. Porter. After completing his studies at the University of Manchester, where he took the degree of B.Sc., and serving an engineering apprenticeship, Mr. Holt Smith entered the Radio Department of the Royal Aircraft Establishment in 1926. His first work there was in connexion with microphones for use in aircraft, to which he made valuable contribution. At a later stage he turned his interest towards direction finding, and invented an automatic direction-finding system which was one of the earliest in the field. For a period he left government service and worked in the research department of the British Broadcasting Corporation, returning to government service in 1938. On his return he became responsible for the direction-finding and navigation work at the Royal Aircraft Establishment, in particular for the direction-finding equipment that was developed for Fighter Command. He then spent some two years at the Telecommunications Research Establishment on antenna research, afterwards serving for a little over a year as assistant director at Headquarters. He returned later to take charge of a flying unit which provided the flying facilities for the Establishment, including the special installation of radar equipment in aircraft. Eventually he became head of the Radio Department there, and as such has been responsible for research and development on airborne and ground radar systems, including radar types of navigational aids, not only for the Fighting Services but also for the Ministry of Civil Aviation.

Tribute to Prof. M. von Laue, For.Mem.R.S.

Prof. Max von Laue's seventieth birthday on October 9, 1949, was an occasion of celebration among German physicists and the world of science at large. Prof. A. Sommerfeld wrote in the *Physikalische Blaetter* that the best way of characterizing him is to call him the most outstanding and the most faithful of Planck's pupils. Laue received his doctor's degree from Planck in 1903, became Planck's assistant in 1905, and the two men always remained close friends. In 1909, Laue went as a lecturer to Munich where, as he puts it, "the atmosphere was saturated with the question whether X-rays were corpuscles or waves", a question which his own discovery soon settled. In 1912, he received the Nobel Prize for it. A tribute to Laue which Sir Lawrence Bragg sent to the *Physikalische Blaetter* includes the following : "I feel that of all living scientists I owe most to Professor Laue for making this discovery. I was just starting my career when it was announced; it decided the subject of my very first researches, and it has formed the basis of my scientific work ever since. This discovery opened up new vistas, a new science has been born as a result of it. . . . By his kindness, his courtesy, his courage, and his staunch adherence to his principles, he has gained international affection and esteem as well as international fame. . . ." Laue proved his courage and staunch adherence to principle during the Hitler regime, and he drew upon himself the wrath of Nazi men of science when he dared, in an obituary, to praise the great merits of Fritz Haber, who had died in exile. When Laue was in America in 1948, he wrote home : "On November 2, I received here in Chicago a honorary doctor's degree. The diploma describes me as 'a physicist and resolute champion of freedom', of which I am very proud. The International Union of Crystallography which, owing to its connexion with the United Nations, may not elect a German to its Board, has made me honorary president for life, and the American Physical Society an honorary member." Recently, Laue was elected a foreign member of the Royal Society (see *Nature*, May 21, p. 794).

Manufacture, Properties and Uses of Toughened Glass

A 16-mm. film on the manufacture, properties and uses of toughened glass was recently shown in London by Pilkington Brothers, Ltd., the manufacturers of 'Armourplate' and 'Armourlight' glasses. The film shows how, following the principle of 'Rupert's drop', glass plate can be toughened by heating to softening point and then rapidly cooling both sides with jets of cold air. The exterior surfaces contract on cooling, but the interior remains hot and plastic and yields to the shrinking. However, when the interior afterwards cools, it undergoes great tensile stresses of contraction which can only be balanced by corresponding compression stresses on the non-yielding outside surfaces. Glass is strong in compression but weak in tension, and breaks when the critical tensile stress is developed on some part of its surface; with toughened glass this point can only be reached after first overcoming the surface compression, and as a result such glass has a breaking strength four to five times (or more, in some cases) that of glass in an ordinary annealed condition. Toughened glass is also very much more resistant to mechanical, and hence to thermal, shock; thus, it will withstand molten lead or, when hot, being sprayed with water. Because of the great strain energy stored within, toughened glass becomes reduced to small harmless granular particles on fracture, but suffers from the disadvantage that it cannot be cut, drilled, chipped, ground or otherwise worked (after toughening) without danger of such disintegration. It returns to the annealed condition at temperatures above 295° C. The film illustrates these properties by suitable demonstrations, and then goes on to indicate the wide range of uses in commerce and industry. It is produced by Cecil Musk and runs for twenty-one minutes. Copies are available on loan from Pilkington Brothers, Ltd., Publicity Department, St. Helens, Lancs.

Jenner Relics at the Wellcome Historical Medical Museum

THE bicentenary of the birth of Edward Jenner (1749–1823) was celebrated last May, and there is still on view at the Wellcome Historical Medical Museum a collection of books, manuscripts, and other relics relating to Jenner and to his discovery of vaccination. The catalogue (obtainable only from the Oxford University Press, 2*s.* net) is an interesting booklet, prepared by Dr. E. Ashworth Underwood, director of the Museum. A brief account of the life and work of Jenner is followed by a description of the contents of the Exhibition. The history of smallpox and of inoculation (or variolation) has been illustrated by a series of books, and portraits of their authors, from Rhazes in the eighth century to Daniel Sutton in the eighteenth. Personal relics of Jenner include the early works on natural history which gained for him the fellowship of the Royal Society, his publications relating to vaccination, his lancets, snuff-box, spectacles, pulsometers, cupping glasses, and the medals which were struck in his honour. Perhaps the principal exhibits, and certainly the most valuable, are two manuscript copies of the famous "Inquiry", written in 1797, and now for the first time placed on view together in the central show-case. The Wellcome manuscript, though not in Jenner's handwriting, is prefaced by a letter from him, while the other manuscript, lent by the Royal College of Surgeons, is written by Jenner himself and labelled by him as "the original paper". Other exhibits deal with the progress of vaccination, the spread of the practice at home and abroad, and the adoption of glycerated calf lymph as first suggested by Robert Koch. The catalogue is an important addition to Jenneriana, and it may well form, not only an essential guide to the Museum, but also a timely tribute to one of the central figures in medical history who, it must ever be remembered, was all his life a country practitioner in a remote Gloucestershire village.

Educational Films on World Resources

THE use of films for educational purposes grows, and a large number is now available. Therefore, a volume emanating from the United Nations is very welcome ("An International Index of Films on the Conservation and Utilization of Resources. Prepared by Unesco for UNSCCUR" (pp. 175; London: United Nations, 1949). The aim is to make available throughout the world material that might be useful in educational circles. There is a subject index, then an alphabetical index of titles, all in English, of some seven hundred films, and finally distribution sources and synopsis of each film. The length in minutes is given and colour or silence are noted, if necessary. There is, so far, no central library from which the films can be procured; but distribution sources are noted. While most films are available only in the language of their country of origin, some are available in English as well as a first language. Thus Danish and Dutch films can be obtained also in English, and most United Nations films in many languages.

Old Stone Age in the Sudan

A RECENT publication by A. J. Arkell, "Sudan Antiquities Service. Occasional Papers No. 1: The Old Stone Age in the Anglo-Egyptian Sudan" (pp. 52+27 plates; Khartoum: Commissioner for Archæology; Cambridge: Deighton, Bell and Co., Ltd., 1949; 25 P.T. or 5*s.*), is of very considerable interest to students of the Old Stone Age. It consists mainly of excellent illustrations of types of palæolithic tools found in the region. The text is kept to a minimum and explains the reproductions and their geographical occurrences. There is a distribution map and a table of a possible succession of cultures in the region, with discussions of geology and climatic changes. The whole is a small but valuable scientific work.

Colonial Students' Welfare in Great Britain

ON January 1 the British Council assumed responsibility for the welfare of Colonial students in the United Kingdom, taking over a task hitherto in the hands of the Colonial Office. The Council is taking over, and will retain for the time being, the Colonial Office hostels in London, Edinburgh and Newcastle, which together accommodate about 460 in shared rooms and dormitories; but its policy is to replace or adapt them so as to provide accommodation of a standard as near as possible to that of university halls of residence. As, however, only a small proportion of the 3,500 Colonial students in the United Kingdom can be housed in such residences, the Council will make every effort to obtain for the others suitable accommodation in boarding or private houses, and staff with this special responsibility have been appointed in London and at British Council centres outside London. It has been providing a range of services to a limited number of overseas students, and these will now be extended to all Colonial students and also to students from the self-governing countries of the Commonwealth and from foreign countries. Though the accommodation in the residences must for the time being be reserved for Colonial students only, it is planned to develop in them social and other activities in which British students will participate. In the London area the British Council is also extending the services it has been providing for its scholarship holders and bursars and some other overseas students, so that they may be available for all the five thousand overseas students in the area.

Rajasthan Academy of Sciences, Pilani

The Rajasthan Academy of Sciences was inaugurated in Pilani on November 27, 1949, by the Hon. Shri Siddharaj Daddha, Minister for Industries and Commerce, Rajasthan. The Hon. Shri Phoolchand Bafna, Minister for Local Self-Government, and the Hon. Shri Narsing Kachwaha, Minister for Labour, were also present on the occasion. The Academy has been started to encourage the progress of science, both pure and applied, in Rajasthan. It will publish, in due course, a *Journal* which will include papers on original research. At a meeting of the 'foundation fellows' of the Academy, Shri M. L. Schroff was unanimously elected president of the Academy for 1949–50, Dr. B. N. Mulay as vice-president, and Shri K. R. Ramachandran, of the Department of Botany, Birla College, Pilani, as secretary.

Congress of Animal Attendants

The Laboratory Animals Bureau is holding a congress of animal attendants during March 30–31 at the Royal Veterinary College, Royal College Street, London, N.W.1. The morning of the first day will be devoted to a discussion on the formation of an Animal Technicians Association, and the morning of the second to the reading of technical papers. Both afternoons will offer a choice between a visit to a biological research laboratory, a programme of scientific films and a trade exhibition. The Congress is open to those, other than university graduates, whose work involves the use, care and handling of laboratory animals; it is not restricted to senior animal attendants. Admission will be by ticket, application for which should be addressed to the Director, Laboratory Animals Bureau, Royal Veterinary College, Royal College Street, London, N.W.1.

Conference on Semi-conducting Materials

A conference on the properties of semi-conducting materials will take place at the University of Reading during July 10–15, 1950. The conference, which is assisted by the United Nations Educational, Scientific and Cultural Organisation, will be under the auspices of the International Union of Physics, in co-operation with the Royal Society, and will be organised by Prof. N. F. Mott and Prof. R. W. Ditchburn. Leading research workers from Czechoslovakia, France, the Netherlands, Sweden, Switzerland, the United States and Great Britain have accepted invitations to contribute papers. Their subjects include the conductive properties of non-metallic solids, photoconduction, barrier-layer rectifiers, crystal triodes, etc., and the relevant theoretical issues. The proceedings of the conference will be published in book form. A general prospectus can be obtained from the secretary, Dr. H. K. Henisch, Department of Physics, University, Reading.

University of London: Appointments

The following appointments in the University of London have been announced: Dr. A. C. Dornhorst, to the University readership in medicine tenable at St. Thomas's Hospital Medical School from October 1, 1949; Dr. W. H. Hughes, to the University readership in bacteriology tenable at St. Mary's Hospital Medical School from October 1, 1949; Mr. Jack Joseph, to the University readership in anatomy tenable at Guy's Hospital Medical School from April 1, 1950.

The title of reader has been conferred on the following in respect of the posts they now hold: Dr. E. H. S. Burhop (mathematics, University College); Dr. Florence N. David (statistics, University College); Dr. C. A. Keele (pharmacology and therapeutics, Middlesex Hospital Medical School); Dr. L. Margaret Kerly (biochemistry, University College); Mr. Hyman Kestelman (mathematics, University College).

Norwegian–British–Swedish Antarctic Expedition

Since Dr. Brian Roberts's article on p. 8 was written, information has been received from the *Thorshovdi* that during the voyage fifteen dogs have died of an as yet unidentified disease. Of the forty-five remaining, which were also infected, thirty-nine have completely recovered. The loss of so many dogs is serious, but it appears that there is now little probability of further deaths from this cause. Huskies are highly susceptible to bacterial and virus infections. All of them had been inoculated against distemper, and eight out of thirty-one from the Falkland Islands Dependencies were lost as a result of an outbreak of hard pad disease before they left England. It seems possible that the latest infection originated with the remaining dogs which came from East Greenland and Spitsbergen.

Announcements

The Adams Prize, offered by the University of Cambridge for an essay on a mathematical, astronomical or natural philosophical subject, has been awarded equally to Dr. J. C. Burkill, lecturer in mathematics in the University, Dr. S. Chandrasekhar, professor of theoretical astronomy in the University of Chicago (Yerkes Observatory), Mr. W. K. Hayman, lecturer in mathematics in University College, Exeter, and Prof. J. M. Whittaker, professor of pure mathematics in the University of Liverpool.

Sir John Lennard-Jones, Plummer professor of theoretical chemistry in the University of Cambridge, has been nominated a member of the honorary Advisory Scientific Committee of the National Gallery.

Mr. A. W. Marsden, director of research, Angus Milling Co., Ltd., and associated companies in Scotland, has been appointed director of the Commonwealth Bureau of Dairy Science, the address of which is National Institute for Research in Dairying, Shinfield, Near Reading.

The Medical Research Council is offering a research fellowship in psychiatry to be provided from a fund established by the late Dr. and Mrs. Edward Mapother. The Fellowship will be awarded to a suitably qualified graduate for whole-time work on the histochemistry of the nervous system, to be carried out under the direction of Prof. A. Meyer and Dr. H. McIlwain at the Institute of Psychiatry (University of London), Maudsley Hospital, Denmark Hill, London, S.E.5. The award will be made for one year, renewable annually for two further years. The stipend will be £600 per annum (with possible increase up to a maximum of £800) with an allowance for research expenses. Applications should be submitted, not later than January 31, to the Secretary, Medical Research Council, 38 Old Queen Street, Westminster, London, S.W.1.

VARIATIONS IN THE DISTRIBUTION OF RADIOACTIVE PHOSPHORUS PRODUCED BY ACTIVITY IN PERIPHERAL NERVES

By Dr. G. CAUSEY and Dr. G. WERNER*
Department of Anatomy, University College, London

USING colorimetric methods for the estimation of phosphorus, Gerard and Tupikova[1] report a proximo-distal gradient in the total phosphorus content of the sciatic nerve of frogs. In a previous review of nerve metabolism, Gerard[2] states that he could find no alteration of the longitudinal distribution of phosphorus on stimulation of the nerve. Roeder[3] reported indications of alteration in distribution of phosphorus in stimulated nerve, but regarded the results as inconclusive. During an investigation of the uptake of phosphorus-32 by rabbit nerves, we have found that gradients of distribution exist when the nerves are active.

The sural nerve and the nerve to the medial head of the gastrocnemius of adult rabbits were used. The sural nerve is distributed to the skin area on the lateral side of the ankle and contains sensory fibres. The gastrocnemius is a typical muscle nerve containing, of course, some afferent fibres.

Phosphorus-32 was injected intravenously in the form of a solution of disodium hydrogen phosphate, and later the sural nerve and the nerve to the gastrocnemius were dissected out in the thigh and upper part of the leg. The portions of nerve so obtained were divided into three approximately equal parts which are referred to as the proximal, middle and distal pieces. After weighing, the pieces were ashed and the solutions 'counted' in a fluid Geiger–Müller counting tube[4] under uniform conditions. All counts were corrected for background and decay and are expressed as counts/min. per 100 mgm. wet weight of nerve per 50 μc./kgm. dose.

Distribution of Phosphorus-32 in the Nerves of Anæsthetized and Unanæsthetized Rabbits

Six rabbits were anæsthetized with urethane or nembutal intravenously, and after 30 min. 1 ml. of radioactive disodium hydrogen phosphate was injected intravenously, representing 30–60 μc. of phosphorus-32 in different experiments; 20 min. later, the nerves were excised. In the proximal, middle and distal pieces of the sural nerve of each animal the counts were not significantly different (Table 1). In the nerve to the gastrocnemius there was a slight decrease distally, with a mean difference of 14 per cent between the proximal and distal counts.

Six rabbits were injected intravenously with 1 ml. of radioactive disodium hydrogen phosphate and allowed to move about the room for 20 min. They were then anæsthetized with urethane or nembutal or killed by a blow on the head, and dissected immediately. In the sural nerve there was found to be a marked fall in the counts distally as compared with proximally, the mean difference between the proximal and distal sections amounting to 37 per cent. In the nerve to the gastrocnemius there was a marked rise distally as compared with proximally, amounting in the mean to 50 per cent (Table 1). The corresponding pieces from the two sides were counted together, except in experiments Nos. 4 and 12.

Distribution of Phosphorus-32 in the Sural Nerve after Stimulation of the Sural Skin Area

These observations suggest that during activity of the nerve fibres, either phosphorus is carried along the nerve or the activity in some way causes a gradient in the rate of phosphorus-32 uptake along the nerve. This result was so arresting that it seemed necessary first to confirm that the gradients only occurred after nerve activity.

Eight rabbits were anæsthetized with urethane. Phosphorus-32 was injected intravenously as before; stimulation by pricking with a needle of the area of skin supplied by the sural nerve on the lateral and posterior aspects of the ankle[5] was begun at once and continued for 20 min. The stimulus was controlled, so far as possible, to produce a withdrawal reflex.

The counts obtained from the three sections of nerve on the unstimulated side did not differ significantly from each other, whereas on the stimulated side there was a marked diminution of the count distally compared with proximally, the differences being significant at less than the 5 per cent level (Table 2).

Table 1. Relative counts in the proximal (*P*), middle (*M*) and distal (*D*) pieces of the sural nerve and the nerve to the medial head of gastrocnemius after injection of phosphorus-32 in anæsthetized and unanæsthetized rabbits

The proximal count has been reduced to 100 in each case

Inactive				Active			
Exp. No.		Sural	Gastrocnemius	Exp. No.		Sural	Gastrocnemius
1	*P*	100	100	7	*P*	100	100
	M	97	98		*M*	86	179
	D	97	97		*D*	59	227
2	*P*	100	100	8	*P*	100	100
	M	98	100		*M*	90	141
	D	93	97		*D*	72	171
3	*P*	100	100	9	*P*	100	100
	M	108	84		*M*	85	141
	D	122	82		*D*	59	154
4*R*	*P*	100	100	10	*P*	100	100
	M	100	87		*M*	85	106
	D	96	67		*D*	63	103
4*L*	*P*	100	100	11	*P*	100	100
	M	97	87		*M*	54	105
	D	96	69		*D*	44	108
5	*P*	100	100	12*L*	*P*	100	100
	M	95	107		*M*	77	125
	D	91	122		*D*	74	139
6	*P*	100	100	12*R*	*P*	100	100
	M	102	97		*M*	87	116
	D	106	90		*D*	73	146
Mean	*P*	100	100	Mean	*P*	100	100
	M	100 ± 4	94 ± 7		*M*	81 ± 11	130 ± 24
	D	100 ± 10	86 ± 18		*D*	63 ± 10	150 ± 39

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* World Health Organisation Fellow.

Table 2. Relative counts in the proximal (*P*), middle (*M*) and distal (*D*) pieces of the sural nerve of the unstimulated and stimulated sides of eight rabbits
The proximal count in each case is reduced to 100

Exp. No.		Unstimulated	Stimulated	Exp. No.		Unstimulated	Stimulated
13	*P*	100	100	17	*P*	100	100
	M	105	44		*M*	102	84
	D	106	27		*D*	108	67
14	*P*	100	100	18	*P*	100	100
	M	90	56		*M*	106	79
	D	80	45		*D*	112	73
15	*P*	100	100	19	*P*	100	100
	M	91	35		*M*	95	80
	D	80	18		*D*	92	65
16	*P*	100	100	20	*P*	100	100
	M	93	92		*M*	102	92
	D	85	81		*D*	97	68
				Mean	*P*	100	100
					M	98 ± 6	70 ± 21
					D	95 ± 12	56 ± 21

Distribution of Red Blood Corpuscles Tagged with Phosphorus-32 in the Sural Nerve and the Gastrocnemius

We next investigated the possibility that the gradient of phosphorus distribution depended on an altered distribution of blood resulting from stimulation.

The blood volume in the three sections of these nerves was investigated by the use of red blood cells tagged with phosphorus-32. 2 ml. of blood was incubated with radioactive phosphorus (20–40 μc.) for 2–3 hr. at 37° C. After centrifuging and washing, a suspension of the tagged red blood cells was re-injected; 5 min. later the nerves were removed and divided into three pieces, which were ashed and counted as described before. It has been shown that no appreciable amount of phosphorus-32 is lost from the red blood cells for 20–30 min., and therefore counts of the nerve pieces are proportional to their red blood cell content[6]. By this means it was shown that the red blood cell content of the proximal, middle and distal pieces of nerve were equal and were not altered in their proportion by either anæsthesia or stimulation. The variation of the content, expressed as counts/100 mgm. nerve, is random, and amounts between different levels of the same nerve or between opposite sides of the same animal to some 8 per cent.

It seems from these observations that the distribution of phosphorus-32, as shown by the counts, in peripheral nerves of rabbits, tends to be uniform in the resting, anæsthetized animal. But a distinct gradient is found when the animal is either moving spontaneously or the sensory end organs of the skin are stimulated mechanically in an anæsthetized animal. Further, it appears that in a nerve carrying fibres for cutaneous sensation the gradient is in the opposite direction to that found in a preponderantly motor nerve.

The uniformity of distribution of tagged red blood cells and the opposite direction of the gradients make it difficult to see any possibility of these phenomena being produced by local changes in blood supply.

Whether the gradients are produced by a local difference of the rate of uptake (or loss) of phosphorus-32 or by substantial transfer of a phosphorus compound with high specific activity should be demonstrable by an analysis of the specific activities of the different phosphorus fractions in the nerve. The whole subject is being further investigated and will be reported in full elsewhere.

We wish to thank Prof. J. Z. Young for his advice throughout this work, and the Royal Society for a grant towards the expenses.

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DYNAMICAL STABILITY OF ANTICYCLONES

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CYCLONES and anticyclones can be identified in weather maps from all parts of the globe, and are relatively restricted both in size and intensity (central pressure excess or defect). In 58 per cent of cases, the size of the subtropical anticyclonic cells lies in the relatively restricted range of 3,000–6,000 km.[1]. This is a fact striking enough to call for explanation, along with others, such as, for example, that the mean intensity of 'lows' in middle latitudes is of the order 20 mb., and not 200 mb. or 2 mb., whereas lows in tropical regions (excluding hurricanes) seldom exceed 4 mb. in intensity.

Little effort has been devoted to the elucidation of facts regarding the size and intensity of pressure-patterns. Rossby[2] has pointed out that the length of standing waves in the westerlies of middle latitudes is of the same order as the size of the large semi-permanent centres of action. More recently Priestley[3], on the basis of his control theory of pressure-variations, has shown that there is an upper limit, depending on the latitude, to the size of stationary systems, and that there is a lower limit to the closeness of approach of discrete patterns. This appears to be the extent of present knowledge of the factors determining the size of pressure-patterns.

It seems reasonable to assume that a discrete system attains a certain shape because that configuration gives the most stable disposition of the available total energy. Any closed dynamical system will tend to re-arrange itself until the total potential energy is a minimum. It would seem that this general principle holds the key to the determination of the size and intensity of pressure-patterns.

This basic principle of dynamic stability does not appear to have been applied previously to wind and pressure configurations on the meteorological scale. The reason may be that the meteorologist is reluctant to follow through to its ultimate conclusion the consequence of regarding pressure-patterns as discrete entities with an inherent structure. Yet as a forecaster, this is a hypothesis he accepts every time he attempts to extrapolate from to-day's to to-morrow's pressure-pattern.

The principle of potential energy minimization applies with particular directness to a plane, circular, gradient-wind anticyclone. It can be shown that the most stable possible organisation for such a system is a barotropic solid rotation with angular speed $\lambda/2$, $\lambda = 2\omega \sin \varphi$ being the Coriolis parameter in latitude φ. The radius R of the solid rotation is a function of the given total energy, and the surface intensity is given by

$$h_0 = \tfrac{1}{8}\rho_0 \lambda^2 R^2,$$

ρ_0 being the surface density. The intensity is determined by R, and R is determined by the total energy, so that the equilibrium anticyclone is completely specified.

Atmospheric anticyclones do not have the structure of a solid barotropic rotation, except, perhaps, near the centre, the reason being that in the real atmosphere frictional forces cannot be ignored. The tendency is for friction to convert kinetic into potential energy, and hence to inhibit the realization of the true dynamical equilibrium of minimized potential energy. Equilibrium in an atmosphere with friction may be looked on as a minimization of potential energy subject to a constraint imposed by the frictional forces, the effect of the constraint being to alter the pressure-profile, and, with it, an associated dimensionless parameter, the *number*,

$$Q = 8\, h_0/\rho_0 \lambda^2 R^2,$$

which in the case of a solid rotation has the equilibrium value unity.

The number was estimated for twenty anticyclones appearing on surface weather maps for the Australian region during the last half of 1948. R was taken not as the 'size' but the 'spread' of the anticyclone, or the radius of maximum pressure gradient. (In the case of a solid rotation the size and the spread are identical.) Individual values are subject to large errors, due mainly to difficulty in evaluating the spread, and range from 1·1 to 3·8 with a mean of 1·9. Although observational error could account for the entire variation in Q, the possibility that the number may vary in different anticyclones cannot be excluded. However, such variation, if it exists, is of the order 2–3 to 1 or less, showing that there is a fairly narrow relation between the intensity and spread,

$$h_0 \approx \tfrac{1}{4}\, \rho_0 \lambda^2 R^2.$$

The intensity of an anticyclone tends to increase with its size, and with latitude, both facts of observation.

The spread of a 'high' depends weakly on the total energy, which may be shown to vary as $\lambda^2 R^4$. Hence 'highs' of quite different energy content in the same latitude will have comparable spreads. We have seen already that the size of subtropical 'highs' tends to bunch fairly closely about the mean value. The intensity of a 'high' of given spread depends on the latitude, an equilibrium 'high' in latitude 60° being three times as intense as one of the same spread in latitude 30°. This agrees with the observation that high-latitude anticyclones are in general more intense.

A cyclonic circulation is not limited to such small values of Q as an anticyclone. In a frictionless atmosphere, the equilibrium number for a cyclone is $Q = \infty$, that is, a cyclone of given intensity would tend to contract to a centrifugal vortex of infinitely small size.

There is, however, one consideration, apart from friction, which might tend to limit Q in a cyclone. It can be shown that if Q is greater than about 10, the vortex will exhibit hydrodynamic instability, that is, although the configuration as a whole may be dynamically stable, individual particles in some regions of the vortex will be unstable to lateral displacement. If we exclude such instability in a steady state vortex, we are limited to numbers of the order 10.

The mean number of seventeen intense cyclones studied by Goldie[4] works out at 9·4, suggesting that the necessity for hydrodynamical stability does, in fact, limit Q for extratropical cyclones. As the stability number for 'lows' is about five times the equilibrium number for anticyclones, 'lows' will in general be more intense, as is known to be the case. The nature of the variation of the intensity of 'lows' with spread and latitude is the same as for anticyclones.

The present investigation is part of the research programme of the Section of Meteorological Physics, Commonwealth Scientific and Industrial Research Organisation, and will be published in greater detail elsewhere.

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SYLVICULTURAL TREATMENT OF TROPICAL MIXED DECIDUOUS FOREST

In a recent paper*, Mr. N. V. Brasnett discusses "Enrichment of Tropical Mixed Deciduous Forest by Planting".

The regeneration of tropical mixed forests of various types has been the subject of investigations for a very considerable period of years in India. Some of the later work of this century in connexion with tropical evergreen or true rain forests has been subjected to what may be termed new treatment, and this treatment had its beginnings in French West Africa, in the Ivory Coast and Cameroons and afterwards in the Belgian Congo and British Uganda Protectorate. The reasons underlying these attempts were mainly due to the fact that the forests in question had been exploited by timber companies which had extracted all the salable species up to and above the girth limit laid down by the Government. These marketable timbers were chiefly mahogany and one or two other species. The forests so exploited were then placed under the Forest Departments and, at the period being dealt with, were practically valueless from the big-timber market point of view, the local demand by the natives being very small.

As has been said, attempts have been made in India and also in Malaya, and, it may be added, in one or two other Colonies, to endeavour to obtain natural regeneration or introduce young plants of valuable species into the dense forests still standing, with the object of enriching them in the future. Success, however, was very doubtful. Leaving out of consideration here the question of Taungya working plantations, the first steps taken in French West Africa and in Nigeria were experimental gap planting. This consisted of planting or dibbling the seedlings of valuable species in natural openings where there was insufficient young advance growth. This plan after a few years trial was not considered practical, since it involved opening small inspection paths connecting the gaps and demanded too exacting supervision from the staff. This gap method was introduced into the Ivory Coast in 1930; but by 1934 it was changed to what may be termed the line method of planting. Strips 10 m. apart were cleared through the forests parallel to one another and planted with nursery transplants 2½ m. apart, the transplants being of valuable species such as mahogany (*Khaya ivorensis*), and in the case of the Ivory Coast *Lovoa klaineana*, *Tarrietia utilis*, *Terminalia ivorensis*, *Entandrophragma utile* and *E. angolense*. This was revised, and the standard practice at present is opening lines 20 m. apart and planting the plants in the lines at 5 m. intervals. This gives an initial stocking of 100 plants per hectare. The work necessitates a considerable labour staff, since weeding and cleaning and climber cutting must be carried out in the first few years—from four to six years—and overhead side-covering must be removed by girdling neighbouring trees. It appears to be generally held in French West Africa that this line planting, although expensive, is simpler to carry out with the available native staff who have not got any real forestry training than to endeavour to establish advance growth and natural regeneration over considerable areas which requires very careful supervision and larger additions to trained staff.

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* *Forestry Abstracts*, **10**, No. 4 (Oxford: Commonwealth Forestry Bureau, 1949).

At first, small nursery transplants were made use of in this planting work. A very considerable mortality ensued from weeds, although these were kept under by the staff employed, from small antelope, which browsed on the plants in the lines thus cleared, and from insects. In 1934 the present writer was shown, in the Ivory Coast, a method which was just starting to be employed. The nursery plants were grown 1½–2 m. high instead of being the smaller stock, and they were stripped of their side-branches except for 2–4 leaves left at the top of the plant. This had the effect of placing the leading shoot out of the reach of browsing deer. They were also less liable to suppression from weeds and less subject to attack by insects. This method was afterwards made use of in the Budongo Forest of Uganda, where considerable development in this matter has been made, as also in the Belgian Congo. It is impossible to go into all the details here; but the main point about this work is the recognition that natural regeneration of the required species is deficient in these exploited forests and cannot be induced in adequate quantity and distribution by any known sylvicultural methods without, perhaps, the employment of an amount of skilled supervision which would prove entirely unremunerative. In the tropical rain forest or evergreen forest, containing a large number of species of trees in mixture, the lower stages of the forest and the forest floor are usually covered with dense evergreen or semi-evergreen woody shrubs and so forth, through which seedlings of the more valuable species that demand a certain amount of light cannot penetrate; and therefore the younger age classes of the valuable species are very scarce or altogether absent. The French and Belgians have standardized 100 plants per hectare, both hoping to obtain 20–50 per hectare in the final crop. In Uganda only about 58 per hectare, in the ultimate hope of obtaining 16–20 per hectare, are planted.

There are no examples of enriched areas more than nineteen years old, and only those up to thirteen years old were made with large plants, that is, 1½–2 m. in size. These are examples of what may be expected from the modern technique. Forecasts of the yield are attempted, but this cannot be very much more than guess-work. Labour costs are estimated at about 75–80 man-days per hectare for all operations up to the final thinning.

It is a pity that this valuable paper was not read before the recent World Forestry Congress at Helsinki which took place the month following the publication. This question of the enrichment of tropical forests was ventilated in more than one section at the Congress, and views were expressed, based obviously on the want of practical experience of the sylviculture of these types of forest and the treatment which it demands, even though a full appreciation of this treatment has not yet been fully realized. Mr. Brasnett with his paper would have been of very real help in the discussions which took place on this subject.

E. P. STEBBING

INDIAN RESEARCH FUND ASSOCIATION

ANNUAL REPORT OF THE SCIENTIFIC ADVISORY BOARD

THE report of the Scientific Advisory Board of the Indian Research Fund Association for the year 1948* includes a comprehensive account of the researches carried out during the year together with the reports of the Advisory Committees for Cholera, Malaria, Nutrition, Leprosy, Plague, Clinical Research, Maternity and Child Welfare, Filariasis, Industrial Health and Pharmacology. The bulk of the work carried out under the Board is, as the titles of these Committees indicate, medical or biological, and a list of papers on medical research published under the auspices of the Association during the year is appended, lists of papers on malaria, nutrition, leprosy and clinical research being also provided with the report of the appropriate Advisory Committee. In the field of malaria, the insecticide and mosquito-repellent inquiry under the direction of the Malaria Institute of India, Delhi, reports some progress with suspensions and emulsions of D.D.T. and 'Gammexane'; Dr. D. N. Roy has continued his study of the control of sandflies, *P. argentipes*, by spraying with D.D.T., and Dr. K. Ganapathi, at the Haffkine Institute, Bombay, his syntheses of thiazoles with a *p*-chlorophenyl-amino group in the thiazole ring and of 4-substituted quinolines for examination as anti-malarials.

Nutrition researches under Dr. V. N. Patwardhan at the Nutrition Research Laboratories, Coonoor, have included studies on the vitamins of the B-complex, on the mode of action of vitamin D and the conversion of carotene into vitamin A in the intestine of the albino rat, on the human metabolism of hydrogenated groundnut oil and experimental lathyrism. At the Grant Medical College, Bombay, Mr. N. C. Datta has studied the formation, function and variations of plasma-proteins in health and disease, while the Nutrition Research Unit under Dr. R. G. Chitre at the Seth G.S. Medical College, Bombay, has investigated the absorption of fats from intestines, the comparative nutritive values of vanaspati vegetable-oil and butter, the nutritive value of milk and curds and of pure-bred strains of cereals and pulses, and the estimation of the so-called "precursor of nicotinic acid" from vegetable foodstuffs and vitamin D. The Nutrition Research Unit under Dr. B. C. Guha at the University College of Science and Technology, Calcutta, has worked on the biosynthesis of ascorbic acid, the biosynthesis of fat with special reference to the role of thiamin and riboflavin, and the biological availability of iron in wheat and other foods. Under Prof. M. Damodaran at the Laboratories of the Council of Scientific and Industrial Research, Delhi, the relation of dietary protein to blood and muscle hæmoglobin, the biological importance of plant carotenoids and the growth-promoting factor present in Bengal grain have been studied.

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* Report of the Scientific Advisory Board for the Year 1948. Pp. xii+245. (New Delhi: Indian Research Fund Association, 1949.) 1 rupee.

Under Dr. Dharmendra at the School of Tropical Medicine, Calcutta, the therapeutic value of derivatives of diamnodiphenyl sulphone in leprosy has been investigated, while under the director of the Haffkine Institute field trials have been conducted with streptomycin, sulphadiazine and sulphamerazine in the treatment of bubonic plague. Research on the experimental production of cancer of the liver in rats by feeding with *p*-dimethylaminoazobenzene has been completed by the clinical research unit at the Tata Memorial Hospital, Bombay, under Dr. V. R. Khandkar, and at the Haffkine Institute the role of nutritional factors in hepatic cirrhosis has been studied by Dr. M. V. Radhakrishna Rao. At the School of Tropical Medicine, Calcutta, Dr. S. Banerji has investigated the effect of vitamin C and vitamin B_1 in diabetes and of vitamin C in hyperthyroidism; Dr. A. K. Mukerji the life-history of *Gastrodiscoides hominis* with a view to preventive measures; Dr. R. N. Chaudhuri the variation of plasma-protein levels and glucose-absorption and glucose-tolerance in the enteric group of fevers; and Dr. J. C. Ray the significance of endogenous allergens in the etiology, diagnosis and treatment of allergic diseases. Appended to the report of the Clinical Research Advisory Committee are a note on the establishment of hæmatological units for standardizing liver extracts manufactured in India and also the rules and regulations for the conduct of clinical trials of new remedies under the Indian Research Fund Association.

Two inquiries into anæmias of pregnancy have been conducted for the Maternity and Child Welfare Advisory Committee; but the greater part of the report of that Committee describes Dr. C. C. Sekar and Dr. Muktha Sen's investigation of the reproductive patterns of an urban area in central Calcutta and a rural area in the Hooghly district. Screening tests against Microfilariæ *in vitro* at the School of Tropical Medicine, Calcutta, are reported by Dr. A. K. Mukerji, while Dr. B. B. Dikshit of the B.J. Medical College, Poona, and Dr. K. Venkataraman, director of the Technology Department, University of Bombay, have investigated the preparation of surface-active antimonials for the treatment of filariasis, as well as the synthesis of 4-hydroxystibanilic acid and derivatives of 4-aminosalicylic acid and the influence of wetting-agents on the antifilarial activity of cyanine dyes. In the field of industrial health, attention has been given to the effects of excessive noise on efficiency, the incidence of lead poisoning in printing presses, sickness absenteeism due to accidents at the Bata Shoe Factory, fatigue and efficiency in paper and textile industries, and the effect of environmental conditions such as lighting, temperature, humidity, ventilation and dust in certain industries in and around Calcutta.

In the field of pharmacology, investigations into indigenous drugs have covered plants yielding essential oils, the male ferns of Kashmir, Indian wild cherry bark, *Dœmia extensa* Linn., the determination of the alkaloids of *Rauwolfia serpentina* in body fluid, the alkaloids of *Cissampelos pareira* Linn. and *Zizyphus jujuba* Lam.

CHEMISTRY AT KING'S COLLEGE, NEWCASTLE UPON TYNE

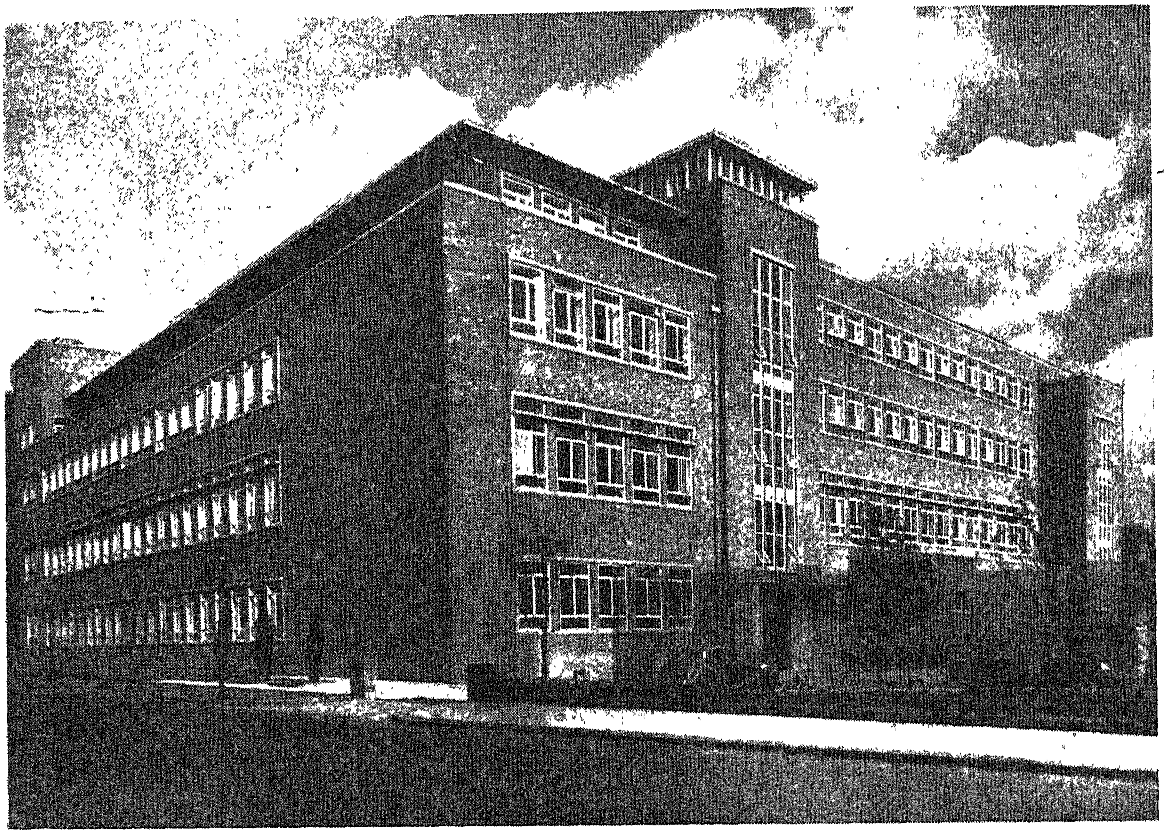
THE new Chemistry Department of King's College, Newcastle upon Tyne, of which the Inorganic and Organic Sections are now completed, was opened on December 10 by Sir Robert Robinson, president of the Royal Society. Viscount Ridley, chairman of the College Council, presided, and was accompanied by the Lord Mayor of Newcastle upon Tyne and the Rector of King's College. The big assembly included representatives of various chemical organisations and of industry in Great Britain, together with many past and present members of staff of the Chemistry Department and of the College as a whole, and a large number of old chemistry students.

Sir Robert Robinson submitted the general thesis that there is still a vast amount to discover about chemistry and that, although he spoke as an organic chemist, he did not doubt that representatives of other branches of chemistry would say the same for their sections. As examples he instanced penicillin and cortisone, and illustrated the point by demonstrating the surprising interaction between urea and *n*-dodecane.

Although the constitutions of both penicillin and cortisone are known and their syntheses have been effected in the laboratory, we have not enough knowledge of chemistry to be able to synthesize them economically on the scale in which they could be used with advantage. Thus the laboratory synthesis of cortisone involves thirty-five stages, and starting with 1,000 kgm. of raw material and assuming a yield of 50 per cent at each stage, only one-twentieth of a milligram of cortisone would be obtained at the end. We must accordingly have much more knowledge of chemistry, and for that reason up to-date and well-equipped laboratories are very necessary. Sir Robert said that a great debt is owed to the authorities of King's College for their achievement in erecting and equipping so magnificent a building in a time of difficulties and shortages.

Organic chemistry occupies a central position in the science between the inorganic and physical branches which merge into theoretical physics, and biochemistry which merges into physiology and medicine. Prof. G. R. Clemo, director of the Department of Chemistry, is an organic chemist and therefore is well qualified to steer his Department "between the Scylla of partiality and Charybdis of impartiality".

In proposing the vote of thanks to Sir Robert, Prof. Clemo compared him to a Wren, a Faraday and a Pasteur in one: a Wren because no chemist approaches him for insight into the structure of Nature's molecular masterpieces; a Faraday because, with Lapworth, he was a pioneer in the application of electrochemical ideas to the explanation of organic chemical reactions; a Pasteur because his unrivalled skill and knowledge have led



New chemistry building, King's College, Newcastle upon Tyne

to, among many other like achievements, the synthesis of stilbœstrol and the elucidation of the structure of penicillin. It is to be hoped that he will add many further such chapters to the glory of chemistry and the good of mankind.

The new Chemistry Department was then opened for inspection. During the evening a reunion dinner was held when many old chemistry graduates of the College attended, headed by Dr. Smythe, who graduated in 1895, and Dr. Watt, who graduated in 1900.

The completed portion of the new Department is L-shaped, and one wing of the basement contains the main stores, connected by a central service lift with subsidiary stores on each floor. In the other wing is the main lecture theatre, seating 275, which occupies both the basement and ground floor. The approaches at basement-level are to the lecture bench from two preparation rooms. The basement in this wing also contains small rooms for electrical equipment, a large centrifuge, a constant-temperature room, and an ice-making plant. The curtains of the theatre can be drawn and the lighting dimmed from the lecture bench, which also has panels for providing A.C. and D.C. electric current at various voltages. Noxious fumes can be removed directly from the bench.

The theatre is approached on the ground floor through foyers at either side. On the left of the entrance hall is a second lecture theatre, seating 145, with lecture bench equipped as for the main lecture theatre; and opening from the far end of this hall is the new Johnston Laboratory, accommodating 144, and used for the teaching of elementary inorganic chemistry. Leading out from the main Laboratory are two balance rooms and laboratories for individual lecturers and the office of the laboratory steward. The private rooms and laboratories for members of staff responsible for the teaching in each of the big laboratories are situated adjacent to the laboratories in question.

On the first floor above this Laboratory are the private room of the reader in inorganic chemistry, two large research laboratories and a teaching laboratory, accommodating 80 honours students, for advanced teaching in inorganic chemistry. Leading from this is a balance room, a constant-temperature micro-balance room, a large special-purposes room containing a Spekker, polarograph, Sands's apparatus, etc., a dark room, and the private laboratory of a lecturer. The research rooms are arranged so that, besides the usual benches and fume-cupboards at the sides, there is a great deal of free floor space with services available from points at or near floor-level, so that large pieces of apparatus can be erected on movable tables or low benches as may be required. An X-ray set with cameras for powder and single-crystal work is available.

On the main landing is the Departmental Library, and in the other wing there is a laboratory at present used for supplementing the teaching of physical chemistry, with a balance room, a dark room and a private laboratory for a lecturer.

The second floor contains the elementary organic laboratory for some 128 students, a balance room and private rooms and laboratories for two lecturers. The Dunn Laboratories, devoted to analytical work in organic chemistry, are also situated here, and consist of a specially fitted laboratory for micro-analysis with its thermostatically controlled balance room, with the balances mounted on special anti-vibration benches, and dark rooms for absorption spectroscopy, polarimetry, etc. In the other wing are a private room and laboratory for a lecturer, and the Advanced Organic Laboratory used by second- and third-year honours students.

The third floor contains the private rooms and laboratory of the professor of organic chemistry, common rooms for staff and research students, and a third lecture theatre to seat 50, with a preparation room and museum. A large and completely equipped laboratory provides accommodation for thirty research workers in organic chemistry, and there are, in addition, a private room and laboratory for one or two members of staff, and a special-purposes laboratory in which are hydrogenation apparatus for operation on various scales from quantitative micro-work to fairly large-scale pressure autoclaves, shakers, a multiple molecular still, refrigerators, apparatus for the quantitative determination of deuterium, filter presses, a large vacuum evaporator, vacuum oven, ozonizer, etc. On the roof there is a laboratory with windows on three sides arranged for experimental work with noxious fumes and equipped with a concrete bench for all-night operations involving gas heating and the use of water. Adjoining is the air-conditioning plant which pumps filtered and warmed air into every room. The temperature of the incoming air, and thus largely that of the building, is controlled by thermostats at key points, and foul air automatically finds its way out of the building aided by fume-cupboard fans through acid-proof ducts. In the laboratories the air is changed six times an hour, and in the lecture theatres twelve times. The fume cupboards in the organic laboratories are situated in the windows.

The benches have been designed so as to render all the services easily accessible, and in case of necessity any service on any bench can be cut off in a few moments without interfering with that service to the remaining benches in the laboratory. The services available to the benches are suited to the type of work carried out on them, and include in the majority of cases electric current at mains and low voltages, hot and cold water, gas and steam. Where requisite, vacuum and compressed air are also provided.

INSTITUTION OF GAS ENGINEERS

AUTUMN RESEARCH MEETING

THE fifteenth Autumn Research Meeting of the Institution of Gas Engineers was held in London, under the presidency of Mr. C. H. Chester, during November 29–30—the first since the gas industry passed into the control of the National Gas Board. The technical matters discussed revealed the continued search for sources of raw material available for making gas or new techniques for carbonization or gasification of solid fuels.

Of great interest was an account of new experience on the process of gas purification with oxide of iron. In Great Britain statutory requirements for the removal of hydrogen sulphide from town's gas are extremely exacting. The method consists in passing the unpurified gas over suitable oxide of iron contained in large boxes, and the process, though effective, has certain disabilities which cause a perpetual if unsuccessful search for substitutes. These disabilities are due to the size and cost of the plant, coupled with the amount and cost of the labour used in operation. In the past, the latter has been due largely to the caking of oxide of iron after 'fouling', and this has been ascribed to accumulation of tarry matter and of salts insoluble in water, in addition to the sulphur deposited. F. J. Dent and L. A. Moignard have put forward a new explanation, although a hint of this was given by H. B. Avery in 1939 when he observed the disintegration and migration of iron in the mass of used oxide. Arising from this, Dent and Moignard have developed an explanation of the caking and hardening of the oxide. In the purification process, the foul gas leaves a film of iron sulphide on the surface of the oxide which, assisted by the moist condition, leads to a migration of iron sulphide and its deposition at points of contact of the material comprising the charge of oxide. This deposit provides the cement for the construction of the hard cakes actually found and causing the above-mentioned difficulties; laboratory tests show that caking can be obtained in the absence of tarry and other deposits. This work has provided, for the first time, a plausible mechanism for the purification of coal gas by means of oxide of iron, and it should be possible, by its application, to secure advances in the efficiency and economy of purification processes.

Removal of tar is, however, necessary in order to recover clean sulphur, which is promoted by the almost complete removal of tar-fog from the gas by electrostatic precipitation. In a paper by K. W. Francombe, it is shown how this technique is growing and will soon be universal practice. R. H. Williamson and J. E. Garside described another way for operating a process of purification without the trouble of caking, that is, to use the new technique of 'fluidization'. The oxide of iron in finely divided condition is carried in a state of suspension by the gas to be purified; in this way the whole process of 'fouling' and 'revivification' is completed without the formation of caked aggregation. On a laboratory scale a measure of success has been obtained.

In the past, town's gas has been obtained by the carbonization of coal, leaving a residue of coke, or by the gasification of solid fuel which has necessitated the use of mineral oil. In recent years, attempts have been made to replace these oils by gaseous hydrocarbons obtained by synthetic processes. F. J. Dent and D. Hebden have described synthetic processes on two lines: (*a*) at atmospheric pressure from a type of 'blue water gas', and (*b*) at a pressure of 20 atmospheres with a hydrogen-rich gas such as could be obtained by pressure gasification of coke or breeze. The results hitherto obtained show such promise that the Gas Research Board is taking steps to continue this work on a larger scale. The synthesis of hydrocarbons from coal to replace those obtained from imported oils and from high-grade bituminous coal would be of considerable national importance.

The manufacture of fuels by carbonization or gasification of coal usually creates trouble by formation of noxious liquid effluents, especially in Great Britain where population is dense and rivers are small. The trouble arises because of poisonous materials such as cyanides, tar acids and bases, and sulphur compounds which remove dissolved oxygen necessary for fish and other life. The new Gas Act of 1948 has placed the responsibility for avoiding the pollution of rivers on the area gas boards. This difficult problem has long been a source of concern to the gas industry and an increasing subject of research. E. H. M. Badger gave an account of the problem of effluent liquor disposal in all aspects. A plea was made for more collaboration by all parties.

H. J. HODSMAN

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

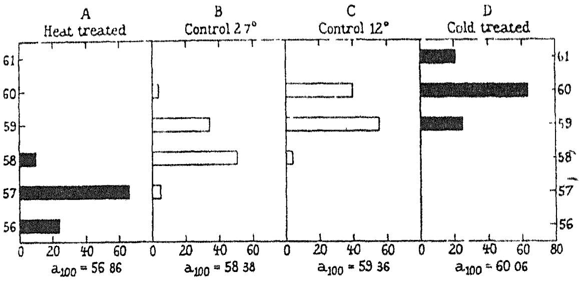
Influence of the Environment on Number of Vertebræ in Teleostean Fishes

For some years now it has been known that the environmental conditions during the development of the fish embryo may exert an influence leading to the number of vertebræ of the offspring becoming different from the number in the parents. Very few experiments, however, have been made on this subject, which is of considerable interest both from the systematic point of view and in the use of racial investigations in applied fishery biology. On earlier occasions, for example, in *Nature* and elsewhere[1], I have referred to some experiments on the sea-trout dealing with this matter. On exposing the developing eggs to varied influences, especially by changing the temperature, we succeeded in determining the period when the temperature had a special effect on the number of vertebræ found later in the fry. The embryo was specially sensitive during a fairly short period, which was called the supersensitive period. A temperature-change of no great amount (3–6° C.) could in this period produce a difference of about 1·5 vertebræ, which is regarded as a great difference when found in so-called races of fish in Nature.

Starting from this result, it seemed, on both theoretical and practical grounds, advisable to try whether even greater differences could be produced in the average number of vertebræ in offspring of the same parents when the eggs in the specially sensitive period were exposed to even greater differences of temperature than used previously. The experiment was carried out on sea-trout in the winter of 1947–48, and the procedure was similar to that used earlier[1]. The eggs were exposed during the supersensitive period to a brief but considerable change of temperature (*c.* 10–13°), in such a way that the eggs which, for example, were developing at c. 12°, received *cold treatment* at *c.* 2·5° for about eight days (equal to *c.* 20 day-degrees), while those developing at a temperature of about 2·7° received *warm treatment* up to *c.* 16° for twenty-four hours (also equal to *c.* 20 day-degrees). After the cold or warm treatment, the eggs were returned to their original temperature, and their development proceeded until the young were old enough for the final number of vertebræ to be determined exactly by means of Alizarine staining and clearing.

Experimenting in this way during the supersensitive period, it was found that differences of no less than 3·2 vertebræ could be produced in the average number of vertebræ in offspring of the same parents. The accompanying diagram shows the results of this experiment, the results for the warm and cold treatment being respectively to the left and right (*A* and *D*) of the control samples (*B* and *C*).

In this species the number of vertebræ varies between 56 and 61, and the treatment has brought out the surprising result that, although they are offspring of the same parents, no variant is common to the samples of cold- or heat-treated specimens. In our long series of experiments, whether with quite small or large temperature changes, there is nothing to indicate that the genetic basis in the specimens treated has changed in any way, that is, the alterations are only phenotypic responses to environmental conditions.



Number of vertebræ in offspring of the same parents (sea-trout), which were subjected during the supersensitive period of the embryonic development to heat (left) and cold (right), both of short duration. The values for the control samples are shown in the middle (*B* and *C*), and the average number of vertebræ (100 specimens) is given under each sample (both parents had 57 vertebræ). *A* : *heat-treated sample* ; reared at 2·7°, but transferred to 16° during a period of 20 day-degrees (from the 147th day-degree to the 167th day-degree) ; *D* : *cold-treated sample* ; reared at 12°, but transferred to 2·5° during a period of about 20 day-degrees (from the 143rd day-degree to the 165th day-degree)

It is worth noting here that a variant distribution almost corresponding to the low values of the heat-treated samples is found in Nature at the southern boundary of the distribution of the trout (for example, in Italy), whereas in northern countries, at its northern limit, the higher variants are dominant. As is known, the southern forms of trout are described as special species or races.

Our experiments have thus produced modifications (comparable to the so-called phenocopies) among offspring of the same parents, which systematists of a generation ago would presumably have taken for separate species, if their origin had been unknown. Similar surprising results have also been found in other meristic characters (fin-rays) in the sea-trout, and these results indicate that one must be careful in using differences in meristic characters in fish populations for taxonomic purposes, even though such differences naturally *may* be due to genetic diversities.

I shall, however, not discuss the results of these and other experiments in further detail here ; a report on them will be published elsewhere.

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[1] Tåning, *Medd. Komm. Danmarks Fiskeri- og Havunders., Fiskeri*, 11, 3 (1944) ; *Nature*, 157, 594 (1946).

D.D.T. and 'Gammexane' as Residual Insecticides against *Anopheles maculatus* in Malaya

Muirhead-Thomson[1] has reported on the use of an experimental hut with a light-trap fitted into the window, as a method of assessing the efficiency of the residual insecticides D.D.T. and 'Gammexane' against *Anopheles gambiæ* in Africa. Similar experiments have recently been conducted against *A. maculatus*, the principal vector of malaria in Malaya. Unlike *gambiæ*, *maculatus* normally leaves houses at or before dawn to rest out of doors by day, and nearly all those captured in an untreated experimental hut were found in the light-trap in the morning.

A preliminary trial with wettable powders of D.D.T. (Stafford Allen's 33 per cent at 100 mgm. D.D.T./sq. ft.) and benzene hexachloride (I.C.I.'s *P*.530 at

20 mgm. γ-benzene hexachloride/sq. ft.), was relatively unsuccessful, due in part to the small numbers of mosquitoes recovered. The internal linings of the two experimental huts were then replaced in preparation for a second trial, in which the insecticides were applied at double the previous dose, that is, D.D.T. at 200 mgm. per sq. ft. and benzene hexachloride (this time *P*.520) at 40 mgm. γ-isomer per sq. ft.; a third untreated hut served as a control.

Fortunately this second trial coincided with the seasonal increase in abundance of *maculatus*, and satisfactory numbers entered each hut to feed on the man sleeping inside. The results during twelve weeks of this trial are briefly indicated in Table 1. Observations are still in progress, and the final results will be reported in full elsewhere.

Table 1. Effect of insecticides upon *A. maculatus* entering trap-huts during twelve weeks after treatment.

Hut	Number recovered	Initial mortality*		Mortality 24 hr. later		Blood-fed		In light-trap		In hut	
		No.	%	No.	%	No.	%	No.	%	No.	%
D.D.T.	341	219	64	294	86	274	80	225	66	116	34
B.H.C	269	236	88	266	99	138	51	212	79	57	21
Control	426	8	2	92	22	383	90	408	96	18	4

* Number found dead in hut and light-trap at 8 a m.

D.D.T. Although this had a little effect in reducing the proportion of *maculatus* biting, 64 per cent of the total recovered each morning were dead, and of the remainder captured alive in the light-trap and then maintained in an insectarium, 61 per cent died within 24 hr., giving an overall mortality after 24 hr. of 86 per cent. The corrected mortality after 24 hr., using Abbott's formula[2], was 82 per cent. There was no evidence of any decline in this mortality during the twelve weeks.

Benzene Hexachloride. No active living *maculatus* were recovered, though a few of those which entered the light-trap lingered on for 24 hr. in a moribund condition. There was a very marked reduction in the proportion biting, and many of the unfed mosquitoes were found dead in the light-trap, suggesting that they had been driven out of the hut by the effects of the insecticide.

Effect on Culicines. Large numbers of culicines, mostly *Culex fatigans*, entered the huts, and observations were made on the mortality and behaviour of these. The numbers entering and the mortality occurring are shown in Table 2, summarized in periods of four weeks.

Table 2. Mortality among Culicines (mostly *C. fatigans*) entering trap-huts

Period in weeks	Control hut			D.D.T. hut			Benzene hexachloride hut		
	Entered	Dead No.	%	Entered	Dead No.	%	Entered	Dead No.	%
1– 4	547	3	0·5	491	64	13	626	526	84·0
5– 8	1,519	34	2·2	1,352	78	5·8	1,397	556	39·8
9–12	867	31	3·6	1,026	80	7·8	617	135	22·0

D.D.T. caused very little mortality, but had an irritant effect, driving the mosquitoes from the hut into the light-trap, and reducing the biting-rate. Benzene hexachloride caused a very high mortality in the period immediately following treatment, falling off gradually over the twelve weeks of the observations. Like D.D.T., it reduced the biting-rate, though to a greater extent, and drove the mosquitoes into the light-trap.

These results agree with Muirhead-Thomson's in showing the great effectiveness of benzene hexachloride, but differ in showing D.D.T. to be lethal to *maculatus*, whereas it was ineffective against *gambiæ*. The effect of D.D.T. on *Anopheles gambiæ* and *Culex fatigans* seems to be rather similar. A large proportion of both species normally rests indoors by day, and in an untreated trap-hut the greater proportion is found each morning in the hut, not in the light-trap; but when D.D.T. is applied the reverse is true. Both species seem to be readily irritated by D.D.T. and driven out of the hut; but few are killed. No irritant effect can be detected in this way for *maculatus*, because its normal habit is to leave the hut. Benzene hexachloride drove a large proportion of *C. fatigans* into the light-trap, but not before many of them had received a lethal dose.

These experiments suggest that both D.D.T. and benzene hexachloride should be effective as residual insecticides against *Anopheles maculatus* in Malaya.

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Aug. 8.

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[1] Muirhead-Thomson, R. C., *Nature*, **163**, 109 (1949).

[2] Abbott W. S., *J. Econ. Ent.*, **18**, 265 (1925)

Growth of Mangels and Long Beet

NUMEROUS observers must have noted in crops of mangels that, attached to portions of the storage organs of these plants, well above soil-level, were numerous lateral roots, hanging in the air and having no contact with the soil. Other lateral roots though still embedded in the soil may have their point of origin several inches above soil-level. Percival[1] points out that in some varieties of mangels the hypocotyl grows up out of the ground. Upward growth of the hypocotyl will not, however, elevate above the soil lateral roots which arise below the level at which the seed was sown. In fact, it is clear in many cases that these lateral roots are raised by the upward growth of the true main root.

In seedlings and young plants lateral roots arise in two ranks and are close together, and they remain so in those varieties which show relatively little elongation of the storage region or in which this elongation is confined almost entirely to the hypocotyl. In some 'long' and 'intermediate' varieties a phase of elongation appears to set in which involves an already thickened portion of the true root which bears well-developed lateral roots, and by upward growth lifts many of them out of the soil. This condition is shown by the plant in Fig. 1 (var. 'Yellow Intermediate'), in which many lateral roots have been torn from the soil by the elongation of a thickened portion of the main root. Fig. 2 shows two plants of the variety 'Red Intermediate' cut longitudinally. In the left-hand plant little elongation, except of hypocotyl, has occurred, and the lateral roots are seen to be crowded together near to the base. In the plant on the right, elongation of the thickened region of the root has occurred and the lateral roots are seen to be widely separated, many of them being lifted above soil-level. Sometimes this elongation is so great as to cause a disruption of some of the older central tissues of the storage organ (Fig. 3). This

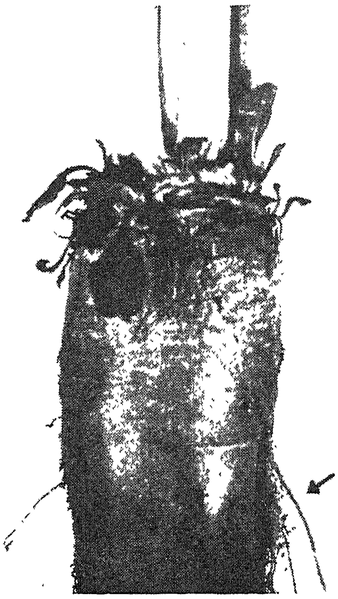

Photo P. *Chambers*

Fig. 1. 'Yellow Intermediate' mangel. The base of the photograph represents soil level Note lateral roots (the largest marked with an arrow) above soil-level

'lifting' of the roots is frequently preceded by some wilting of the foliage, and the older leaves of the plant may remain in a wilted condition for several weeks or even permanently. We must assume that this wilting (which occurs irrespective of climatic or soil drought) is caused by the severance of some of the lateral roots from intimate contact with the soil, as the swollen part of the main root commences its elongation.

This wilting is even more marked in the two varieties of long garden beet, 'Exhibition Black' and 'Cheltenham Green Top', than it is with any of the types of mangels observed. These two green-leaved varieties of long beet, with us, invariably exhibit a wilting of the foliage, the former variety about July 25–28, and the latter variety approximately a week later. With the variety 'Exhibition Black', the wilting is followed after an interval of about ten days by the appearance of the 'root' above soil-level. The wilting is not due to a soil-water deficit. Its onset may coincide with a period when the soil is wet and heavy rain falling. Further, the wilting occurs two to three days earlier when the plants are widely spaced (approximately two plants per foot of row), and consequently large, than when they are more closely spaced (approximately four plants per foot of row), although competition for soil water is likely to be most acute when the plants are closely spaced. With these beet any subsequent upward elongation is due mainly to hypocotyl growth, although frequently sufficient elongation of the thickened portion of the root occurs to lift a few lateral roots out of the soil. As with mangels, we can only assume that the wilting results from an interruption of the intimate contact formerly existing between lateral roots and the soil, so that irrespective of the water content of the soil, insufficient water absorption occurs to maintain all the foliage in a state of turgidity.

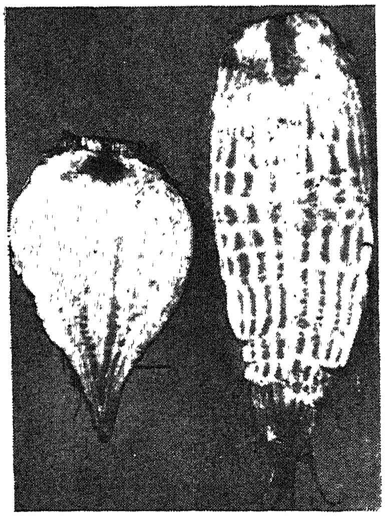

Photo : P. *Chambers*

Fig. 2. 'Red Intermediate' mangels, cut longitudinally. In the plant on the right, elongation of the main root has occurred and the lateral roots are well separated. In the plant on the left, elongation is confined almost entirely to the hypocotyl, and the lateral roots are crowded together near the base of the storage organ. (Photographed July 27, 1949)

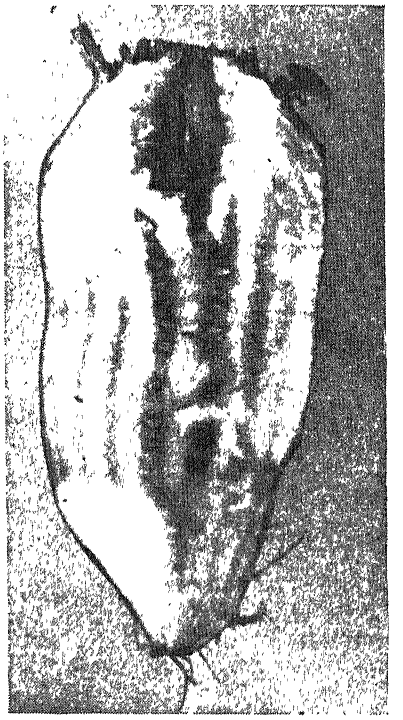

Photo . P. *Chambers*

Fig. 3. 'Golden Tankard' mangel, cut longitudinally. Elongation of the storage organ has resulted in disruption of some of the older tissues. (Photographed July 27, 1949)

The beet plants which wilt in this way never completely recover, but remain with their older leaves permanently wilted. The two varieties of beet which exhibit this character are also (with us) marked by the 'clean' roots they produce, that is, the absence of strongly developed lateral roots. Six other varieties of long garden beet ('Selected Purple', 'Dells Black-leaved', 'Non-Bleeding', 'Exhibition Crimson', 'Fine Dark Red', 'Covent Garden Red') grown for purposes of comparison did not exhibit any wilting of the foliage, and many of these varieties do develop strong lateral roots. Whether the association of green leaves, absence of strongly developed lateral roots and wilting is more than fortuitous cannot be said. Neither can we say whether the wilting which occurs is indicative of an internal water deficit sufficiently serious to restrict growth. It is noteworthy that one of the varieties concerned ('Cheltenham Green Top') is a popular variety among commercial growers and hence is presumably at least not markedly inferior to other varieties in its cropping capacity.

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Nov. 11.

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[1] "Agricultural Botany", London (1910).

A Technique for Studying Infection of *Dracunculus* in *Cyclops*

The study of the relative infectivity of *Dracunculus* larvæ in various species of *Cyclops* which we undertook at the Department of Parasitology in the University College, Ibadan, involved the examination of thousands of *Cyclops*. Ordinarily there are two ways of identifying infected *Cyclops*: to examine them alive, which could be done if one is dealing with a few specimens; or, when large numbers have to be dealt with, to stain them in bulk and then examine them, one by one, later.

A live infected *Cyclops* in a drop of water on a slide is easily recognized with the low power of the microscope because of the vigorous lashing movement of the *Dracunculus* larvæ (it is rare to find only one larva in an infected *Cyclops*) inside the body cavity. It is necessary to immobilize the *Cyclops* temporarily by some means to stop it darting about on the slide. The substance used for this purpose must be such as will have no effect on the larvæ inside, for if these, too, are immobilized their identification will be difficult, especially in the breeding season when the body cavity of the *Cyclops* is generally filled with large coloured dense cells which will later give rise to eggs or spermatophores.

A few drops of 10 per cent alcohol added to about a dozen *Cyclops* in 2 c.c. of water in a watch-glass generally produce the required effect in two minutes and keep them in that state for about five minutes while the *Cyclops* are examined individually under the microscope. One has to make sure of the exact quantity of narcotizing material used, since if this is too weak the *Cyclops* do not stay immobilized long enough, while, if too strong, they will be permanently adversely affected later, on their return into the culture jar.

The method of staining works well if, after fixing the *Cyclops*, they are kept in a jar of 5 per cent caustic potash for 24 hours before staining. If this is not done, the staining will fail to show up the larvæ because the overlying muscle bands in the cephalothorax of the *Cyclops*, taking up the stain better than the larvæ underneath, will obscure them.

Both methods involve individual examination of the *Cyclops*, so that, apart from being very tedious, they are not suitable when numbers running into thousands are to be dealt with in a short time.

Recently, while working on the effects of low temperature on infected *Cyclops*, it was observed that the chill-coma temperature of *Cyclops* was 10° C. while that of *Dracunculus* larvæ was 7·5° C. (Details of this work are reported elsewhere.) Thus at any temperature between 7·5° and 10° C. the *Cyclops* are effectively immobilized while the contained larvæ are active and moving about, and, as such, are spotted without any difficulty. This, therefore, provides a method of rapidly counting the number of infected *Cyclops* in a dish containing more than a hundred. All that is necessary is to put into this dish sufficient crushed ice to cool the water to, say, 8° or 9° C., while a count is made with a binocular microscope, or, if desired, a separation into infected and uninfected groups is effected. *Cyclops* treated in this way suffer nothing and can undergo the same treatment several times without any apparent harm.

If it is not necessary to keep the *Cyclops* alive after the count is made, a more convenient way is to put them in a refrigerator for 24 hours. A few minutes after returning them to room temperature the larvæ will be seen to be moving about vigorously in the infected *Cyclops*, while any of the latter that have not already been killed by the cold can only resume normal activity after several hours.

The advantages of using the differential chill-coma temperature method in studying *Dracunculus* infection in *Cyclops* are four-fold, namely: (1) it enables one to deal with more than a hundred *Cyclops* in a dish at once instead of examining them one by one on a slide; (2) it eliminates the risk of under- or over-narcotizing the *Cyclops*, as often happens when 10 per cent alcohol or some other narcotic is used; (3) when the temperature is merely reduced to about 8° C., the *Cyclops* can be returned to the culture jar without any ill-effects after a count is made; (4) the process is very easy to carry out.

A similar technique may be applicable in the study of other parasitological problems.

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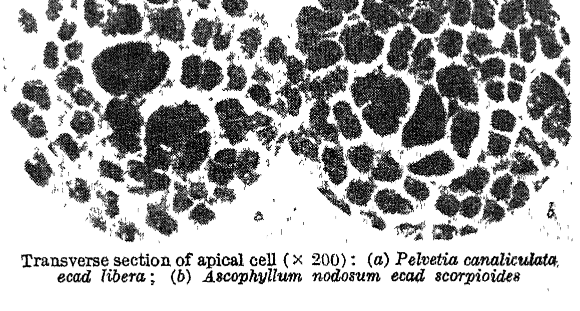
Apical Cell of Salt Marsh Fucoids

I have been studying the anatomy of the British salt marsh fucoids under the direction of Prof. V. J. Chapman. While Prof. Chapman was at Manchester in 1946, Prof. I. Manton, as a matter of interest, examined the apical cell of *Fucus vesiculosus ecad volubilis* and found that it was in the three-sided juvenile state. On this basis, Prof. Chapman in his book "An Introduction to the Study of the Algæ" surmised that the three-sided juvenile condition of the apical cell may be common to all marsh forms of the fucoids, and this has proved to be correct.

The accompanying photomicrographs are of *Pelvetia canaliculata ecad libera* and *Ascophyllum nodosum ecad scorpioides*, and show clearly the three-sided apical



Transverse section of apical cell (× 200): (*a*) *Pelvetia canaliculata, ecad libera*; (*b*) *Ascophyllum nodosum ecad scorpioides* cell. Similar photographs are available showing a three-sided apical cell in *Fucus spiralis* var. *nana*, *Pelvetia canaliculata ecad coralloides*, *Fucus ceranoides megecad limicola*, *Fucus vesiculosus ecads cæspitosus* and *muscoides*.

It is now suggested that the lack of sexual reproductive organs in these marsh fucoids is not so much a matter of their environment, as suggested by Baker and Bohling[1]; but is instead a direct result of the retention of the juvenile apical cell. It may be supposed that the juvenile three-sided cell does not produce the growth-substance that stimulates the formation of sexual reproductive organs, or alternatively it may produce an inhibitor to the reproductive growth-substance. It would be interesting if workers in Great Britain were to study this aspect with the view of its confirmation or otherwise.

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July 24.

[1] *J. Linn. Soc. London*, 43 (1916).

A Decline of Citrus Plants in Venezuela

DURING the past year, the survey of a number of small *Citrus* groves has led me to conclude that a disease similar to "tristeza" is present in Venezuela, chiefly in the States of Carabobo and Aragua up to Sucre; western areas were not investigated. The disease has been previously attributed, by local agronomists, to high or deficient soil moisture or to an unclassified root injury, for the decay of rootlets, then of larger roots, occurs simultaneously with decline of the tops.

The symptoms are closely allied to the "podredumbre de las raicillas", described in Argentina, or "tristeza" of Brazil; the same disease has been found in Uruguay, and eventually in California[1].

In Venezuela, the disease has been recognized only when citric plants were cultivated on a commercial scale, and when sweet orange, local or introduced, was grafted on sour rootstock. (A peculiar die-back, of doubtful etiology, has been occasionally observed, for example, near Valencia, also on ungrafted sweet orange, at first with leaf yellowing, also with some vein yellowing and stunting of the young tree.)

As a rule, symptoms of the disease are later obscured by the interference of other causes of decline.

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July 7.

Benett, C. W., and Costa, S. A., *J. Agric. Res.*, 78, 207 (1949).

Oxidation of Catechol by Tea-Oxidase

DURING the enzymic oxidation of catechol, approximately two atoms of oxygen are taken up for each molecule of catechol, whereas only one atom is required for oxidation to the *o*-quinone stage. Wagreich and Nelson[1] consider this extra uptake to be accounted for by the interaction of the *o*-benzquinone with water to form 1 : 2 : 4-trihydroxybenzene, which then reacts with a further molecule of *o*-benzquinone to produce hydroxy *o*-quinone and a molecule of catechol. Their evidence that a polyphenol is produced from *o*-benzquinone, capable of being oxidized to an *o*-quinone by tyrosinase, is convincing. That the polyphenol produced is identical with catechol cannot be taken as established. The scheme has also been strongly criticized by Wright and Mason[2].

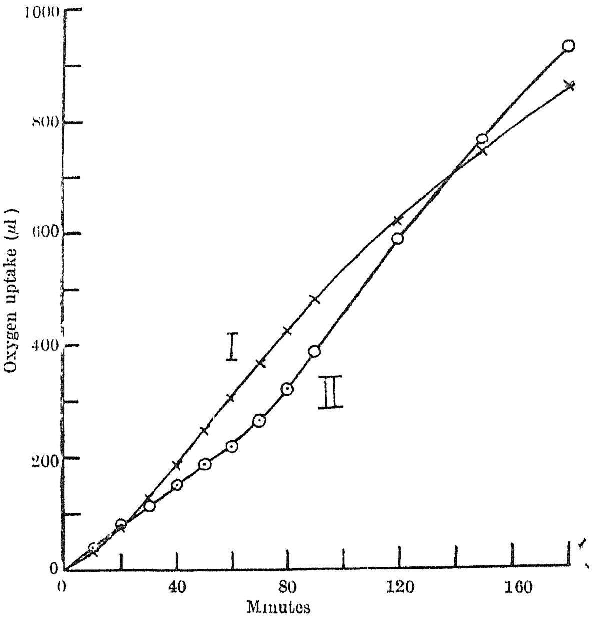

Fig. 1. Oxygen uptakes. I. 40 mgm. washed enzyme + 11 mgm. catechol at pH 5·6. II. 40 mgm. washed enzyme + 3 mgm. ascorbic acid

We have studied catechol oxidation by the tea-oxidase, and some of our experimental results are at variance with the Wagreich and Nelson mechanism of catechol oxidation.

Using an enzyme preparation of acetone-dried tea leaf, washed exhaustively with water to remove adsorbed polyphenols, the oxygen uptake curve with 11 mgm. catechol at pH 5·6 is autocatalytic (Figs. 1 and 2). As *o*-benzquinone is not autoxidizable[1], it seems likely that this autocatalytic rate is due to the production of a polyphenol, formed as an oxidation product of catechol, which is more rapidly oxidized

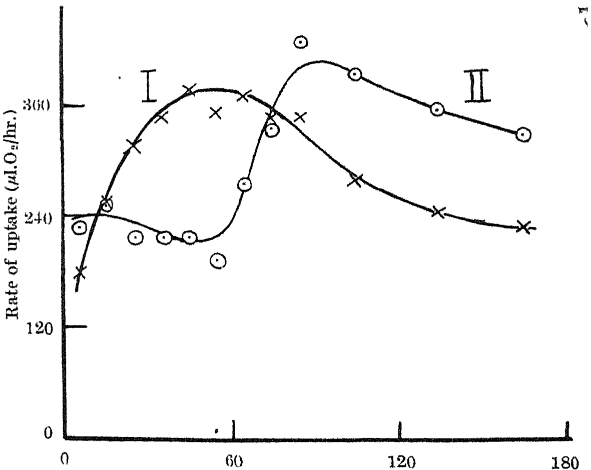

Fig. 2. Results in Fig. 1 replotted in terms of rates of uptake. With catechol alone (I) the rate increases with time for the first 60 min. In the presence of ascorbic acid (II) the rate is constant for the first 60 min. and then increases with time for the second 60 min.

Oxygen uptake (μl.) with 40 mgm. water-washed, acetone-dried tea-oxidase at *p*H 7·2 (phosphate)

Substrate	10	20	30	40	50	60 min.
15 mgm. catechol	37	82	127	175	213	256
„ + 3 mgm. ascorbic acid	24	53	80	110	135	161

by the tea-oxidase than catechol. Tyrosinase presumably oxidizes this new polyphenol at a lower rate than catechol, so that in this case an autocatalytic uptake curve is not obtained.

Support for this view is provided by the results observed when ascorbic acid is added to the system. In the presence of ascorbic acid, the rate of uptake is linear and at a significantly lower level than when no ascorbic acid is present. Reduction of the *o*-quinone, immediately on its formation, prevents the formation of the more rapidly oxidized polyphenol, so that the rate observed is that of catechol oxidation alone, uncomplicated by the formation of a more rapidly oxidized substrate. When all ascorbic acid is oxidized (3 mgm. = 190 μl.) the *o*-quinone is no longer reduced and the reaction-rate then becomes autocatalytic (Figs. 1 and 2).

At *p*H 7·2 the *o*-quinone is much less stable than at *p*H 5·6, and formation of the new polyphenol is more rapid. Consequently, a slow building up in the rate of oxygen uptake is less likely, and the rate shows only slight acceleration with time. On the other hand, the proportion of the uptake due to oxidation of the second polyphenol is greater in the initial stages, so that ascorbic acid produces a greater inhibition of the rate of uptake, as shown in the accompanying table.

Neither the autocatalytic rate of uptake at *p*H 5·6, nor the depression of the rate of uptake in the presence of ascorbic acid, can be accounted for if catechol is regenerated as a result of the disappearance of *o*-benzquinone from the system. On the other hand, these observations find a complete explanation if, instead of catechol, another polyphenol, oxidized more rapidly by tea-oxidase, is formed as a product of *o*-benzquinone. We cannot at present identify this polyphenol, although there is nothing in our results to exclude the possibility that it may be 1 : 2 : 4-trihydroxybenzene. In this case our mechanism differs from that of Wagreich and Nelson only in that the trihydroxybenzene is oxidized enzymically and not by *o*-benzquinone.

Further details of this work will be published elsewhere later.

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Tocklai Experimental Station,
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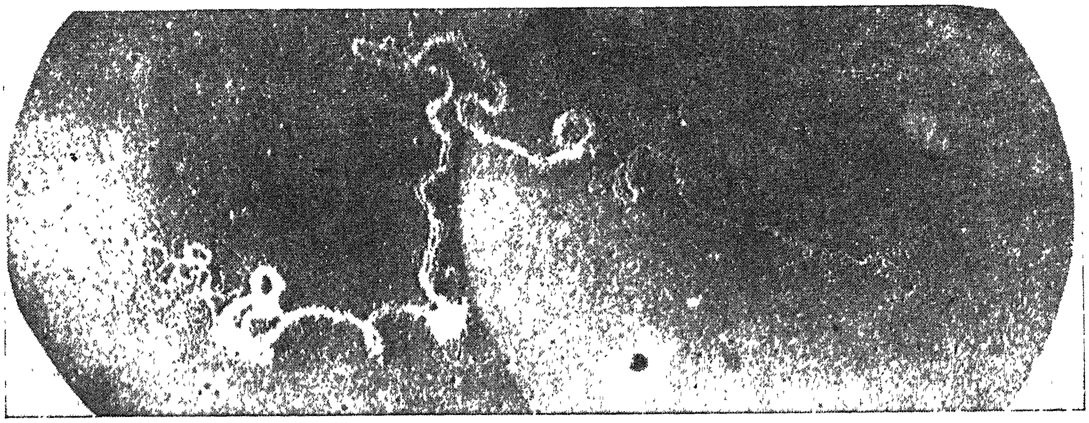
Cinnamara P.O., Assam.
June 29.

[1] Wagreich, H., and Nelson, J. M., *J. Amer. Chem. Soc.*, **60**, 1545 (1938).

[2] Wright, C. I., and Mason, H. S., *J. Biol. Chem.*, **165**, 45 (1946).

Electron Micrograph of a Chromosome of *Triton*

Developing further the technique employed in our laboratories by Zalokar[1], we have obtained in our electron microscope (Trüb Tauber, electrostatic) a very large number of pictures of chromosomes of the ovocytes of *Triton*. The accompanying reproduction shows a typical one. These chromosomes were fixed with acetic acid and 'microcentrifuged'[2] on the collodion membrane.



Chromosome (or part of it) centrifuged on collodion membrane, gold-shadowed and enlarged 10,000 times

M. Danon
E. Guyénot

Laboratoire de Zoologie,

E. Kellenberger
J. Weigle

Laboratoire de Physique,
University of Geneva.
July 18.

[1] Dinichert, Guyénot and Zalokar, *Rev. Suisse de Zoologie*, **54**, 283 (1947).

[2] Kellenberger, *Experientia*, **6**, 253 (1949).

Anterior Pituitary Explants of Infantile Rats Grafted in the Anterior Eye Chamber of Hypophysectomized Hosts

In an earlier communication[1], we have shown that hypophysectomized rats, irrespective of the length of time during which they were hypophysectomized, responded to pieces of the anterior pituitary introduced in the anterior chamber of the eye by a prompt resumption of growth. Some such grafted pieces of the anterior pituitary survived for periods of sixteen months, showing signs of their activity, as reflected by the growth of the host animal, during all that time. Two animals with sixteen-months old grafts are still alive and still growing.

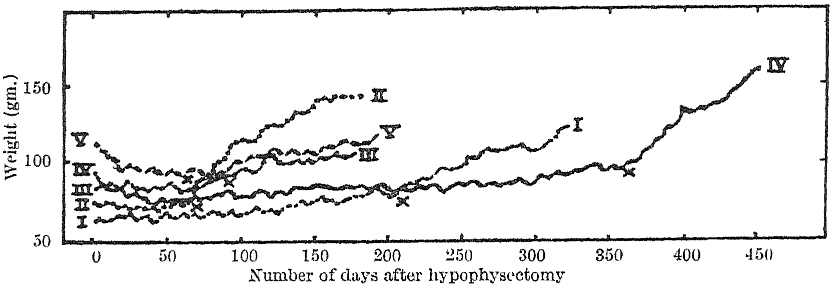


Fig 1. Curves of growth of five hypophysectomized rats with explant grafts. ×, Day on which graft was implanted in eye

In our earlier publications[2], we have shown that pieces of the anterior pituitary of infantile rats can survive *in vitro* in equal parts of chicken plasma and chicken embryo extract at 34° C. for as long as four months. Two months old explants grafted in the anterior eye chamber of normal hosts lived there for several weeks; when sectioned and stained, they did not differ much from pituitary grafts taken directly from the donor.

The object of the present experiment was to find out the fate of cultures, capable of remaining active for a long period, of pieces of the anterior pituitary if grafted into the anterior eye chamber of hypophysectomized hosts.

Pieces of the anterior pituitary of infantile rats (12–18 days old) were cultivated by the watch-glass technique in rat plasma, chicken plasma and chicken embryo extract in the proportion of 6 to 3 to 3 at 34° C., the medium being changed every seventh day. All the explants showed visible signs of activity. They vigorously liquefied the plasma medium, especially during the first three weeks. An appreciable number of cells migrated into the surrounding medium. Migration of cells from the mother tissue in some cases continued for as long as seven weeks. That some of the migrating cells must have been parenchyma cells there can be little doubt; but our interest was centred upon the mother explant itself. After 32 days of cultivation, the explants (six to twelve in number), each of them consisting of what was left of one half of the anterior lobe, were grafted in the anterior eye chamber of five hypophysectomized hosts, whose age at hypophysectomy, duration of the hypophysectomized state and the duration of life following grafting are shown in Fig. 1.

All these five animals, as can be seen from the curves of their growth before and after the grafting operation was performed, like animals with pituitaries transplanted directly from the donor, gave an *immediate* response to the grafted explants by a sudden resumption of their process of growth. This rather unexpected reaction found what is most likely its logical explanation when control-pieces of the anterior pituitary kept *in vitro* for 32 days and longer were sectioned and specifically stained; in this case the Severinghaus technique was used. In the stained preparations, it was observed that the mother explant contained a large number of acidophile cells, besides an even larger number of neutrophiles, which stained just as intensely and as beautifully as do the cells of the same type taken directly from a normal fully grown donor (Fig. 2). These cells in sectioned preparations usually occupy a band-like area between the necrotic centre and a thin layer of surface cells devoid of colloidal granules.

After six and seven weeks of cultivation, the whole explant begins to show signs of degeneration; but in some of the explants healthy-looking acidophile cells were found after sixty-five days of their *in vitro* life. A fair number of damaged acidophiles and a few healthy-looking cells of the same type were observed even after eighty-three and ninety days of cultivation (Fig. 3). This shows that in our cultures acidophile cells were capable of surviving as long as the explant itself. No cells suggesting basophiles were to be seen in these cultures.

Explants grafted for three months in the anterior eye chamber of hypophysectomized rats, when sectioned and stained, were shown to contain a large number of intensely staining acidophiles, which was not the case with infantile pituitaries (12–16 days old) grafted directly from the donor. In the latter case the acidophiles were only faintly stained.

Hence this method gives a reliable and simple technique for the study of acidophile cells *in vitro*. Cultivated in chicken plasma, chicken embryo extract and rat plasma of adult animals at 34° C., these cells survive in a practically unmodified state for many weeks. A detailed report of this work will be published elsewhere.

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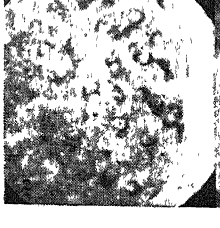

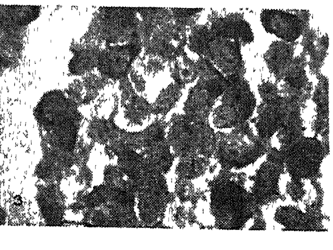

Fig. 2. Photograph of a 32-day-old *explant* of the anterior pituitary of an infantile rat. Acidophiles intensely stained. Stained with Severinghaus technique. × 225

Fig. 3. Photograph of 90-day-old *explant* of the anterior pituitary of an infantile rat. Four acidophile cells clearly visible. Stained with Severinghaus technique. Highly magnified

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[1] Martinovitch, P. N., "Functional Pituitary Grafts in the Rat" (published in reprint form by the Serbian Academy of Science, June 20, 1949).

[2] Martinovitch, P. N., *Medicinski pregled*, 7 (1940).

Chemical Constitution of Slippery Elm Mucilage: Isolation of 3-Methyl D-Galactose from the Hydrolysis Products

THE mucilage obtained from the bark of the slippery elm tree (*Ulmus fulva*) was reported by Anderson[1] to occur as the partially methylated derivative (OMe, 4·6 per cent of the polysaccharide). From an investigation of the hydrolysis products of the polysaccharide, he concluded that it contained D-galactose, L-rhamnose and D-galacturonic acid, and, in addition, he found indications which suggested the presence of a partially methylated aldose sugar and a pentose sugar. Later, Gill, Hirst and Jones[2,3] investigated the chemical structure of the mucilage by the methylation procedure; only the methylated derivatives of D-galactose, L-rhamnose and D-galacturonic acid were detected, however.

The identity of the material containing the methoxyl groups, and which occurs in the natural polysaccharide, was therefore unknown, and its separation and identification was attempted by the use of paper partition chromatography. The mucilage was hydrolysed in *N* sulphuric acid for nine hours with the formation of an aldobiuronic acid, designated as 2-D-galacturonosido-L-rhamnose[2], and a mixture of reducing sugars. After separation from the aldobiuronic acid, the mixture of reducing sugars (*A*) was separated into its components on a sheet of filter paper by partition chromatography[4]. From the rate of movement[5] of the sugars on the paper chromatogram and from the colours produced on spraying with aniline trichloracetate[6], α-naphthylamine trichloracetate[7], and diphenylamine trichloracetate[7] and subsequent heating, it was deduced that galactose, either 3-methyl galactose or talose, rhamnose and an unknown sugar (traces) were present.

Accordingly, a portion of the sugar mixture (1·2 gm.) was separated on a column of cellulose[8] by partition chromatography, using a mixture of *n*-butanol (95 per cent) and ethanol (5 per cent), nearly saturated with water, as the mobile phase. Using this technique, pure crystalline specimens of D-galactose, L-rhamnose and 3-methyl D-galactose were obtained on evaporation of the solvent. The identity of the 3-methyl D-galactose follows from the following observations.

(1) Its position on the paper chromatogram corresponds exactly with that of a known specimen of 3-methyl galactose (R_G 0·17). (2) $[\alpha]_D + 87°$ equilibrium value (*c*, 0·29 in water); OMe, 14·3 per cent (calc. for $C_7H_{14}O_6$. OMe, 16·0 per cent). (3) The change in optical rotation of a solution of the methyl galactose in 4 per cent methanolic hydrogen chloride from a positive value ($[\alpha]_D + 62°$) to a negative value ($[\alpha]_D - 43°$), thus indicating the presence of a free hydroxyl group on C_4. (4) M.p. 140–141°, undepressed on admixture with an authentic specimen of 3-methyl D-galactose. (5) An X-ray powder photograph of the crystals was identical with that of 3-methyl D-galactose.

The detection of 3-methyl D-galactose in a natural product is unique, as in the case of the isolation of D-tagatose from *Sterculia setigera* gum[9], and again serves to illustrate the utility of paper partition chromatography for the analysis of the complicated mixtures arising from the hydrolysis of polysaccharides.

Quantitative analysis[10] of the sugars (*A*) produced on hydrolysis of the gum showed the presence of galactose, 20·8 per cent (calc. as $C_6H_{10}O_5$), 3-methyl galactose, 19·1 per cent (calc. as $C_7H_{12}O_6$) and rhamnose, 7·9 per cent (calc. as $C_6H_{10}O_4$).

We wish to thank Prof. T. Reichstein for a specimen of 3-methyl D-galactose and Dr. T. Malkin for carrying out the X-ray examination.

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Aug. 3.

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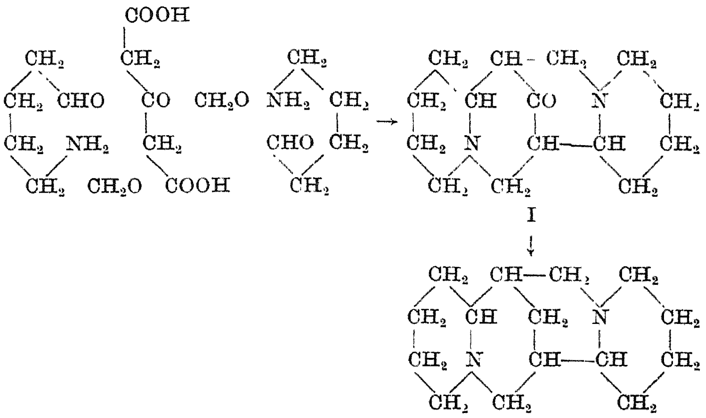
[1] Anderson, E., *J. Biol. Chem.*, **104**, 163 (1933).
[2] Gill, R. E., Hirst, E. L., and Jones, J. K. N., *J. Chem. Soc.*, 1469 (1939).
[3] Gill, R. E., Hirst, E. L., and Jones, J. K. N., *J. Chem. Soc.*, 1025 (1946).
[4] Partridge, S. M., *Biochem. J.*, 42, 238 (1948).
[5] Hirst, E. L., Hough, L., and Jones, J. K. N., *J. Chem. Soc.*, 928 (1949).
[6] Partridge, S. M., *Nature*, **164**, 443 (1949).
[7] Hough, L., Jones, J. K. N., and Wadman, H., *J. Chem. Soc.* (forthcoming publication).
[8] Hough, L., Jones, J. K. N., and Wadman, W. H., *J. Chem. Soc.*, 2511 (1949).
[9] Hirst, E. L., Hough, L., and Jones, J. K. N., *Nature*, **163**, 177 (1949).
[10] Hirst, E. L., and Jones, J. K. N., *J. Chem. Soc.*, 1661 (1949).

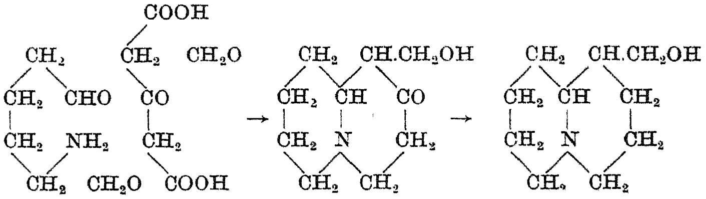
A Synthesis of Sparteine

THE scheme for the formation of sparteine suggested by Robinson[1] in his theory of the phytochemical synthesis of alkaloids is incorrect, being based on the then prevailing erroneous conception of its structure. Clemo, Raper and Short[2] have since shown clearly that the alkaloid must have the structure (II). However, a logical extension of Robinson's general ideas leads to the following formulations for the biosynthesis of sparteine (II) and lupinine (III).



I

II



III

In each case the last step is thought to proceed through the stages: reduction to an alcohol—dehydration—reduction. The condensation reactions suggested are obviously of the same kind as those proposed by Robinson for other alkaloids. Moreover, they clearly point to a close relationship between *iso*-pelletierine, lupinine, cytisine and the alkaloids of the sparteine group. The latter are possibly derived from sparteine itself by oxidation, reduction and dehydration reactions.

A synthesis of *dl*-sparteine along these lines has now been effected. Acetone dicarboxylic acid and δ-aminovaleraldehyde (prepared by the mild acid hydrolysis of its acetal) were allowed to react in dilute aqueous solution at *p*H 13 at room temperature for several hours. Then, after adjusting the *p*H to 7, formaldehyde was added. From the reaction mixture 8-keto-sparteine (I) was isolated in 15–20 per cent yield, which on Clemmensen reduction afforded a nearly quantitative yield of *dl*-sparteine, identified by the melting points and mixed melting points with authentic specimens of several of its derivatives and by their analyses.

Further experiments on the synthesis of sparteine, lupinine and related alkaloids are in progress.

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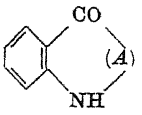
[1] Robinson, R., *J. Chem. Soc.*, 111, 876 (1917).

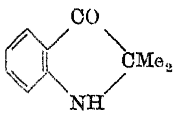
[2] Clemo, G. R., Raper, R., and Short, W. S., *J. Chem. Soc.*, 663 (1949).

Revision of the Structural Interpretation of the Reactions and Properties of Certain Derivatives of Tetrahydrocarbazole and Related Compounds

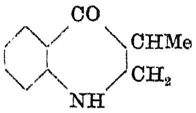
IT is now known that all substances of the form (I), in which *A* is a saturated hydrocarbon residue, are yellow, fluorescing blue or violet in benzene or ethereal solution, and blue-green, or green, in hydroxylic solvents.



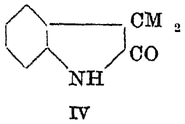
I



II



III



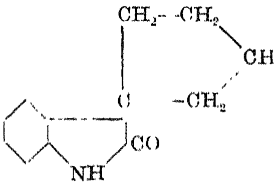
IV

Several substances have, however, been regarded as of type (I) which are colourless and non-fluorescent, and it is the object of this communication to point out that the evidence relied upon in these cases was inadequate and that a different formulation is necessary. For example, Bucherer and Grolée[1] submitted the anilino*iso*butyric acid of m.p. 185° to the action of sodium ethoxide and potassium hydroxide at 270–320° and obtained a colourless substance, $C_{10}H_{11}ON$, m.p. 150–151°, to which they attributed one of the structures (II) or (III). The properties of this compound suggest, however, that it is dimethyloxindole (IV), which has melting point 152–153° [2] or, less probably, 3-methyl-2-keto-1 : 2 : 3 : 4-tetrahydroquinoline.

This synthetic reaction was a model for the preparation of a series of substances such as the so-called pseudoindoxyl*spirocyclo*hexane[3], formulated like (II) because the alternative type (III) could here be eliminated as the result of parallel experiments in the hydro-acridine series.

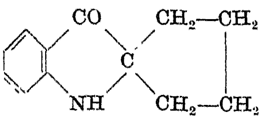
A re-examination of this and similar substances, and also of the so-called pseudoindoxyl*spirocyclo*pentane prepared from tetrahydrocarbazole[5] by a series of processes has convinced us that all of them are 3 : 3-disubstituted oxindoles. The hydrocarbostyril alternative is not rigidly excluded in some cases, but the preparation of stereoisomeric 5-keto-2 : 3 : 4 : 5 : 6 : 13-hexahydro-α-quinindenes[5] shows that a hydroquinolone hypothesis is inapplicable to the so-called pseudoindoxyl*spirocyclo*pentane, which can only be oxindole*spirocyclo*pentane (V). The details will be published later; but it may be mentioned that the behaviour with alkalis, the fact that a primary amino-group can be liberated by hydrolysis under certain conditions, and the comparison of various reactions with those of undoubted 3 : 3-dimethyloxindole (IV), are regarded as quite conclusive. This positive evidence supplements the negative aspect that the substances under consideration are colourless and non-fluorescent, and hence are not dialkylated indoxyls.

The Bucherer–Grolée synthesis must be due to fission and recombination, and the former process was observed in the case of 1-anilino-*cyclo*hexanecarboxylic acid (cf. ref. 3).

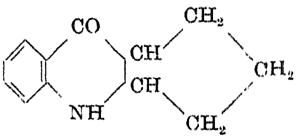


V

On the other hand, the so-called '11-hydroxytetrahydrocarbazolenine' of m.p. 79–80° (ref. 4) has all the properties of a substance of type I, and on this account must be the real pseudoindoxyl*spirocyclo*pentane (VI) or the hydroquinolone (VII).



VI



VII

It is of interest that this substance has also been obtained by the action of alkalis on tetrahydrocarbazole peroxide[6], and it may be that the later stages of the two processes are identical.

Pseudoindoxyl*spirocyclo*pentane (2 : 2-tetramethyleneindoxyl) (VI) has now been independently synthesized by treatment of N-acetylindoxyl under benzene and nitrogen with sodamide and tetramethylene chlorobromide, followed by alkaline hydrolysis of the product. The yield was very small and the purification difficult, probably due to the formation of substituted dibutylindoxyls and 1 : 2-tetramethyleneindoxyl. The small quantity of pure material eventually isolated crystallized from light petroleum in yellow needles m.p. 78–79°, alone or mixed with the supposed 11-hydroxytetrahydrocarbazolenine.

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Nov. 15.

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ucherer and Grolée, *Ber. deut. chem. Ges.*, **39**, 991 (1906)
ancher and Bettinalli, *Gazetta*, **29**, 1, 115 (1899).
Betts, Muspratt and Plant, *J. Chem. Soc.*, 1311 (1927).
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[5] Blount, Perkin and Plant, *J. Chem. Soc.*, 1975 (1929).
[6] Beer, McGrath, Robertson and Woodier, *Nature*, **164**, 363 (1949).

A Yellow Pigment Formed from *Para*-Aminobenzoic Acid and *Para*-Aminosalicylic Acid by Various Strains of *Mycobacterium*

We have previously shown that *para*-aminobenzoic acid is transformed into a yellow pigment by various species of mycobacteria[1,2,3]. The chemical composition of this pigment is unknown; but it has been established as an oxidation product of *para*-aminobenzoic acid. The pigment is insoluble in water and in most of the usual organic solvents, but is very soluble in phenol and glacial acetic acid. Various substances related to *para*-aminobenzoic acid, with the exception of procaine, were unable to form this pigment.

We have found, as with *para*-aminobenzoic acid, that *para*-aminosalicylic acid is transformed into a yellow pigment by *Mycobacterium smegmatis* and the closely related strain, *Mycobacterium tuberculosis* var. *hominis* No. 607, both of which organisms are naturally resistant to *para*-aminosalicylic acid. The conditions under which the *para*-aminosalicylic acid pigment is formed closely resemble those described for the formation of *para*-aminobenzoic acid pigment. It is noteworthy that replacement of glycerol by glucose strongly inhibits the formation of the pigment. In the presence of *para*-aminobenzoic acid, the biosynthesis of riboflavin by mycobacteria[4] is more rapid and the amount formed appreciably increased. *Para*-aminosalicylic acid has the same influence as *para*-aminobenzoic acid on the production of riboflavin.

Para-aminosalicylic acid pigment differs from the *para* aminobenzoic acid pigment in several respects: (1) its colour is more reddish; (2) it is partially soluble in water and especially soluble in diluted acids and alkali; (3) it is much less stable than *para*-aminobenzoic acid pigment. The colour of the pigment rapidly changes to a dark brown within the first few days of growth.

Pigment production by *Mycobacterium smegmatis*

Pigment produced	Colour of pigment	No pigment produced
Para-aminobenzoic acid	Yellow	In addition to substances already mentioned (Mayer[2]):
Acetyl *para*-aminobenzoic acid	Yellow	*o*- and *m*-Aminobenzoic acid
Para-aminobenzoyl-diethyl-amino-ethanol (procaine)	Yellow	*m*- and *p*-Hydroxybenzoic acid
Para-aminosalicylic acid	Orange-yellow	*o*-Hydroxybenzyl alcohol
Para-nitrobenzoic acid	Yellow	2,4-Dihydroxybenzoic acid
3,5 Dinitrobenzoic acid	Orange-yellow	*o*- and *m*-Phenylenediamine
3,5 Dinitrosalicylic acid	Orange-yellow	*m*-Aminophenol
Folic acid	Orange	2,4-Diaminophenol Acetyl derivatives of *o*-, *m*- and *p*-toluidine 2,4,6-Triaminotoluene 3 and 5-Nitrosalicylic acid

In the accompanying table are named a number of substances capable or incapable of pigment formation.

A great number of related substances had definite antibacterial activities. The following substances were bacteriostatic in concentrations of 0·025 per cent or greater: 3,4-diaminotoluene, 2,5-diaminotoluene, 2,4-diaminotoluene, catechol, resorcinol, *para*-phenylenediamine, *o*- and *p*-aminophenol, 1,2,4-triaminobenzene, *p*-aminoacetophenone.

In the presence of salicylic acid and acetyl salicylic acid, another pigment is produced which differs from the *para*-aminobenzoic acid pigment, as seen from its behaviour to fluorescent light.

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Carol Crane

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Ciba Pharmaceutical Products, Inc.,
Summit, New Jersey. Aug. 5.

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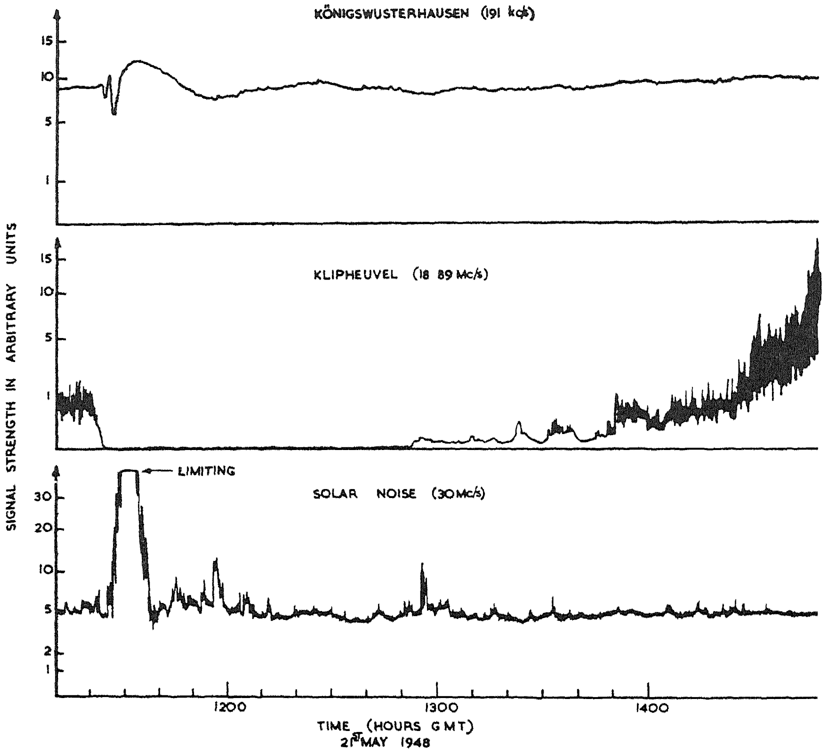
[1] Mayer, R. L., *Science*, **98**, 2539 (1943).
[2] Mayer, R. L., *J. Bact.*, **48**, 337 (1944).
[3] Mayer, R. L., *J. Bact.*, **48**, 93 (1944).
[4] Mayer, R. L., and Rodbart, M., *Arch. Biochem.*, **11**, 49 (1946).

Solar Noise and Ionospheric Fading

A study of the correlation between the occurrence of bursts of solar noise and anomalies in ionospheric wave propagation was initiated at the Radio Research Station, Slough, by Mr. R. E. Burgess in 1948 and continued during that year by Messrs. C. S. Fowler and R. W. Mason. Some interesting effects on radio transmissions in the low-frequency band at times of sudden ionospheric disturbances have been observed.

In the course of this work simultaneous recordings were made of the relative intensity of solar noise at frequencies of 30, 42, 73 and 155 Mc./s. and of the strength of signals from the stations of Klipheuvel, South Africa, on 18·89 Mc./s., and Königswusterhausen, Germany, on 191 kc./s. On a number of occasions a burst of noise was accompanied by a complete fade-out (of the Dellinger type) of the high-frequency signal and a marked fluctuation in the level of the low-frequency signal. The most outstanding example occurred at about 1130 G.M.T. on May 21, 1948, at the time of a large solar flare which has already been reported[1]. The records for the two stations and for the noise on 30 Mc./s. are reproduced in the accompanying figure.

The main feature of the record to which I wish to direct attention is the variation of the low-frequency signal during the fade-out. As pointed out by Dr. B. G. Pressey, the nature of this variation is characteristic of interference between the ground and ionospheric waves caused by a change in the phase and amplitude of the ionospheric wave; and this could be explained by a change in the equivalent height of reflexion together with an increase in the effective reflexion coefficient of the ionosphere. Normally the intensity of the ionospheric wave from a low-frequency station at this distance (975 km.) is relatively small at noon; but the record shows a considerable increase of intensity over a period of ten minutes which is approximately the same as the duration of the noise burst. The relative phase-change during the disturbed period is seen to be about two cycles, which corresponds to a change in equivalent height of reflexion of about 10 km., if a



Records of signal strength of Königswusterhausen, Klipheuvel and solar noise

normal height of 80 km. is assumed. The return to normal conditions seems to be complete by the end of the high-frequency fade-out at about 1400 G.M.T.

Physically, this effect may be explained by the increase in ionization density producing a well-defined lower boundary on the reflecting region which, travelling rapidly downwards, reduces the equivalent height of reflexion and also decreases the length of the path of the wave through the lower absorbing levels.

It is to be noted that the start of the low-frequency anomaly and of the high-frequency fade-out occurs some five minutes before the burst of solar noise.

The work referred to above was carried out as part of the programme of the Radio Research Board, and this letter is published by permission of the Department of Scientific and Industrial Research.

R. L. SMITH-ROSE

Radio Research Station,
Ditton Park, Slough, Bucks.
Aug. 4.

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[1] "A Brilliant Solar Flare, 21st May 1948", *Observatory*, 68, 191 (1948) (Two letters, from H. Barton and H. W. Newton.)

Ionosphere and Weather

FOR some ten years, at the Zi Ka Wei Observatory, in Shanghai, China, we have been using, with exceptional success, a new technique in our weather forecasting. This method is based on an as yet unexplained correlation between the usual ionosphere echoes (E, F and F_2) and the future movement or behaviour of the three main air masses, which make the weather all over the world: polar, maritime and tropical, or equatorial, as some people call it. Our results have already been published in the *Bulletin of the Meteorological Society of America*, in 1946, and in a paper sent to the last Pacific Science Congress held in New Zealand last February.

We found, in 1939, in Zi Ka Wei that by pulsing on the mean critical frequency for the E-layer at our station (6 Mc.), any day of the year after sunrise and before sunset, we could forecast what type of air mass would make the weather over an area of 400 km. around Shanghai. For example, we found that when we had an E-echo, the maritime (Pacific Ocean) air mass would either stay over us, if it was already there, or it would come over us, if at the time of pulsing another type of air mass was covering our regions. When we obtained an F-echo, the polar (Siberian) air mass would make the weather, while an F_2-echo meant the arrival of the tropical air, or its staying if already there. Knowing by this technique the type of air mass due to make the weather, we could forecast its future characteristics, dry or damp, overcast or clear, windy or calm, good or bad visibility, high or low temperatures, etc.

In frontal weather conditions, no echoes are obtained; that kind of weather would then continue for the next twenty-four hours.

When a typhoon had been located, on the weather map, at about 200 miles distance, an E-echo would show that the maritime air mass would bring the cyclone dangerously close to us. An F-echo would show that no danger was threatening the Shanghai area, since the typhoon would recurve.

We have tried this new technique in Hong-Kong, with the generous help of Mr. S. P. Heywood, director of the Royal Observatory, during the last typhoon season and have obtained results just as good as those mentioned for Shanghai.

It would be very interesting to see if also in Britain such a weather forecasting technique would yield the same results. All that is required is a self-oscillating radio circuit, with an output of about 100 watts. The pulsing should be obtained by using a special grid leak, namely, a very good 0·01-μF. fixed condenser with a 2-MΩ fixed resistor in parallel. Any good communications receiver, without the usual transformer output, connected to an ordinary cathode-ray oscillograph, would show the ionospheric echoes.

Weather maps to be consulted should be drawn according to the types of air masses and not to show only the high- or low-pressure values. The values of these pressures do not show the kind of weather prevailing in these high or low areas.

If two different echoes show in the screen of the oscillograph, most attention should be given to the more dominant type.

E. GHERZI, *S.J.*
(Director for Meteorology
and Seismology)

Zi Ka Wei Observatory, Shanghai.

Relief of Internal Stresses by Precipitation

During an investigation of the recrystallization of two-phase silver–magnesium alloys, it has been observed that precipitation occurring in one of the phases, after deformation but before recrystallization, increases the temperature at which recrystallization starts in that phase.

This was shown in the following way. A silver alloy containing 31·8 atomic per cent magnesium (9·5 weight per cent) was water-quenched from 600° C., and an alloy containing 32·3 atomic per cent magnesium (9·7 weight per cent) was slowly cooled to 300° C. and quenched to room temperature. Both alloys, which then contained almost identical volume fractions of the two phases, were deformed by drawing to 80 per cent reduction in area and annealed at 350° C. for 30 min. During this annealing, the crystals of the α-phase recrystallized fully in both alloys. The crystals of the β-phase were almost fully recrystallized in the slowly cooled alloy, but showed no sign of recrystallization in the quenched alloy. Heavy precipitation of the α-phase occurred in the β-crystals of the quenched alloy, giving rise to a Widmanstatten structure, but no precipitation occurred in the slowly cooled alloy. This is shown in the microstructures, Fig. 1, *a* and *b*. The fact that precipitation occurred in the quenched but not in the slowly cooled alloy is in agreement with the phase diagram of the silver–magnesium system[1].

Fig. 2 shows the back-reflexion X-ray diagrams of the two alloys after annealing at 350° C. The inner ring is the 330 Debye–Scherrer circle of the β-phase and the outer ring is the 333 Debye–Scherrer circle of the α-phase. The top portion (Fig. 2, *a*) is half the diagram of the slowly cooled alloy; it shows a spotted ring of the β-phase, indicating practically complete recrystallization of this phase. The lower part (Fig. 2, *b*) is half the diagram of the quenched alloy. Here the Debye–Scherrer circle of the β-phase is still continuous, which shows that no recrystallization has occurred; however, the sharpness of the ring indicates that the internal stresses which had been present in the alloy due to the plastic deformation and had given rise to line broadening have been relieved.

When specimens of the deformed alloys were annealed at 300° C. the β-phase did not recrystallize in either case, and the β-lines in the X-ray patterns were broad, due to the deformation. These lines were sharper, however, in the diagram of the quenched alloy. Precipitation had occurred in this alloy but not in the slowly cooled alloy.

The conclusion is drawn from these experiments that the precipitation occurring in the quenched alloy is responsible for the relief of the internal stresses, thus reducing the tendency for recrystallization.

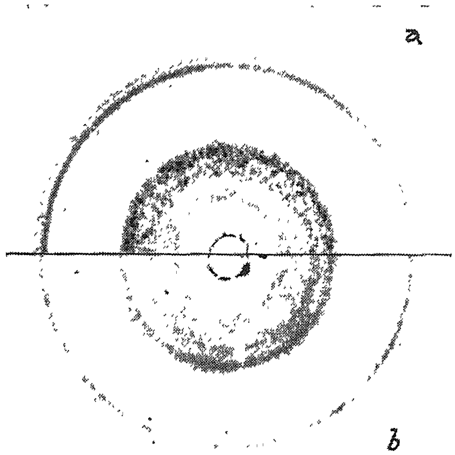

Fig. 2. Back-reflexion X-ray diagrams of alloys annealed at 350° C. (*a*) Slowly cooled alloy; (*b*) quenched alloy

An explanation of this effect seems possible in terms of the dislocation theory. The dislocations in the deformed β-phase diffuse to the regions of misfit at the new boundaries created by precipitation, where they are no longer effective in causing internal stress. Cahn[2] suggests a similar movement of dislocations for stress relief by polygonization.

The work described in this paper was carried out as part of the research programme of the Division of Tribophysics, Commonwealth Scientific and Industrial Research Organisation.

L. M. Clarebrough

Division of Tribophysics,
Commonwealth Scientific and
Industrial Research Organisation,
University of Melbourne, N.3.
Aug. 2.

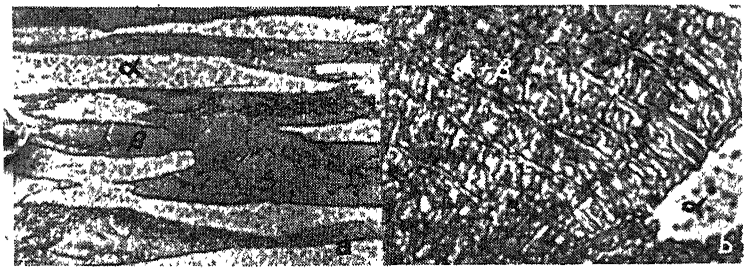

Fig. 1. Photomicrographs of silver–magnesium alloys annealed at 350° C.

(*a*) Slowly cooled alloy; β-phase almost fully recrystallized (× 680) (*b*) Quenched alloy; Widmanstätten structure in β-phase (× 2,100)

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[1] Andrews, K. W., and Hume-Rothery, W., *J. Inst. Metals*, **69**, 485 (1943).

[2] Cahn, R. W., Phys. Soc., Rep Conf. on Strength of Solids, 136 (1948).

Elasticity and Rupture of Concrete and Stone at Constant Rates of Loading

Experiments have been made to study the elasticity and rupture of concrete and stone cubes of 4-in. side while being loaded to failure in compression in a testing machine. An ultrasonic pulse was propagated through the cubes and, at intervals throughout the loading, the time of transmission of the leading edge of the pulse was measured across the concrete. The pulse travels through the medium with a velocity (V) which is related to the elasticity by the relation:

$$V^2 = \frac{E\,(1-\sigma)}{\rho\,(1-2\sigma)\,(1+\sigma)}, \qquad (1)$$

where V is the longitudinal wave velocity, E the elasticity, ρ the density, and σ is Poisson's ratio for the medium.

The transmission times were measured to an accuracy of better than 1 per cent by a technique which has been described elsewhere[1].

Measurements of the longitudinal wave velocity were made vertically, in the direction of application of the load, and also horizontally across the cube. The piezo-crystal assemblies used for transmitting and receiving in the vertical direction were mounted in holes of $1\frac{1}{16}$ in. diameter by $\frac{5}{8}$ in. deep in two mild steel plates 7 in. square by $1\frac{1}{4}$ in. thick. These steel plates were then placed between the top and bottom faces of the cube and the plattens of the testing machine. In the horizontal direction a further pair of crystal assemblies was clamped across a pair of opposite faces of the cube.

Concrete Cubes. With increasing load the longitudinal wave velocity, measured vertically, remained sensibly constant up to failure. Thus from equation (1) the elastic modulus, as measured by infinitesimally small changes of dynamic stress, remains constant. Creep will no doubt occur and the actual strain will be of the form:

$$\text{strain} = \frac{\text{stress}}{E} + C(t), \qquad (2)$$

where $C(t)$ is the contraction due to creep, which depends upon the rate of loading[2].

In the horizontal direction the longitudinal wave velocity remained constant up to only a fraction of the ultimate failing load and thereafter decreased with increasing load. The decrease was attributed to internal rupture of the specimens along vertical planes. The load at which the decrease initially occurred was found to depend upon the age and type of concrete, but was independent of the rate of loading from 600 lb./sq. in. per min. to 5,000 lb./sq. in. per min. The percentage change in longitudinal wave velocity with load is shown in Fig. 1 for a concrete with mix proportions 1 : $1\frac{1}{2}$: 3/0·40 at ages of three to ninety days, and it will be seen that initial cracking occurred at about 35 per cent of the ultimate failing load.

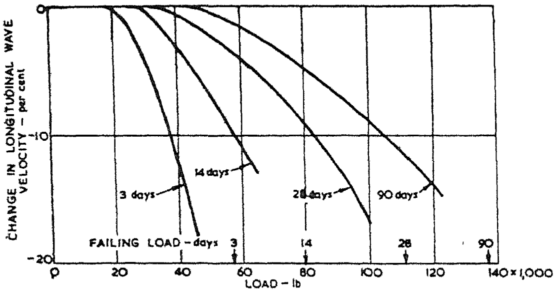

Fig. 1. Change in longitudinal wave velocity at right angles to direction of load in concrete cubes

The initial rupture and development of cracks in the concrete probably depend upon the stress distribution throughout the cube, which is affected by the contact conditions between the cube and the plattens of the testing machine. It is hoped to carry out further tests with rubber pads between the cube and the plattens to reduce the friction, and also on larger specimens in which failure occurs in a section having a uniform stress distribution.

Stone Cubes. Similar tests were made on 4-in. cubes of basalt and York stone. In the basalt cubes the longitudinal wave velocity, in the vertical direction, remained constant to beyond the start of internal rupture. At right angles to the direction of the load the longitudinal wave velocity remained constant to near the failing load before it began to decrease.

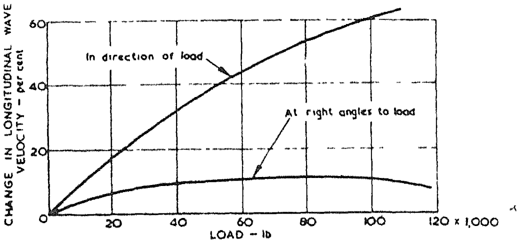

Fig. 2. Change in longitudinal wave velocity in York stone cube

With the York stone the longitudinal wave velocity, in the vertical direction, increased with load, as may be seen from Fig. 2. Such an increase in elasticity with load has been observed previously for porous rocks[3] and is attributed to the closing of the voids under load. At right angles to the direction of load the longitudinal wave velocity increased slightly until the onset of internal rupture.

The work described in this note was carried out at the Road Research Laboratory of the Department of Scientific and Industrial Research as part of the programme of the Road Research Board. The note is published by permission of the Director of Road Research.

R. JONES

Road Research Laboratory,
Harmondsworth, Middlesex.
July 28.

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[1] Jones, R., *Mag. Concr. Res.* (in the press).

[2] Glanville, W. H., "Studies in Reinforced Concrete". III. "The Creep or Flow of Concrete under Load." Department of Scientific and Industrial Research, Building Research Technical Paper No. 12. (London: H.M. Stationery Office, 1930.)

[3] Zisman, W. A., *Proc. U.S. Nat. Acad. Sci.*, **19**, 653 (1933).

An Equal-Stepped Tuning in a Ganda Harp

THERE is a widespread impression that African music follows principles which are completely outside European tonal conceptions. Accurate data, however, which would enable students of exotic music to clarify this issue, are very rare. It is therefore of interest that it has been possible to demonstrate an equal-stepped pentatonic tuning in Uganda.

Apparatus. The apparatus used in the present study was a chromatic stroboscope, as described by Young and Loomis[1]. It offers the great advantage of accurate, rapid readings and of eliminating human prejudice in the identification of frequencies and the interpretation of intervals.

Musician. The African expert, Mr. Temuseo Mukasa, helped the author in musicological studies once before, in 1939. As a 'King's musician' at the court of the Kabaka of Buganda, as a pupil and successor to the late Mr. Jemusi Mayanja—the greatest harpist of them all—and as a musician of life-long experience on the bow-harp, he made a competent assistant well versed in the tradition of his art.

Musical instrument. The instrument was an 8-stringed harp without supporting pillar, of a design peculiar to Uganda. In this variety of harp the tension of the strings gives rigidity and strength to the structure. Thus change in tension of one string is likely to act on the neck and affect its arch and alter the pitch of the others. Much of the harpist's time and attention is therefore given to tuning and to the maintenance of the strings, and an experienced player acquires great skill in this connexion. The strings are manufactured by a specialist, graded in thickness, and different methods of treatment are practised in order to obtain good service.

Tuning procedure. The harpist goes through the tuning process in three stages or operations.

(1) He begins with string No. 1, the highest note of the series. This is tuned, in Mr. Mukasa's case, to a note in the neighbourhood of $G4$ (G above middle C); this was found already to be his practice in 1939. Then string No. 2 is tuned at an interval with string No. 1 of roughly 240 Cents (1 Cent = 1/100th of a tempered semitone; [1 C = 1200/log 2])[2]. It is rather important to have this interval fixed satisfactorily, because on its size depends the position of the following intervals. This process is continued with similar values step by step until string No. 8 is reached.

(2) It is difficult to check up on a tuning of this type where merely a traditional, memorized pattern can be drawn upon as norm. The following method is adopted in order to exercise some kind of control. Nos. 1, 2 and 3 are struck in quick succession, followed by Nos. 2, 3 and 4 struck in the same way, and so forth until the test is completed with Nos. 6, 7 and 8. All patterns are meant to be identical, merely based on a different string every time, and if the same series of intervals or the same impression is to be obtained from every one of the six test patterns, then all steps must be sufficiently equal to yield this result. It is in this sense that the term 'equal-stepped' is used.

(3) The third and last method employed to ensure a satisfactory tuning is the checking of the octaves. Nos. 1 and 6, 2 and 7, and 3 and 8 are intended to form octaves, and, indeed, Mr. Mukasa has been very successful in this task. The octaves deviate from the perfect interval by not more than 12, 2 and 8 Cents respectively. Good octaves are the hall-mark of the efficient tuner; in the case of a Uganda xylophone team, for example, adverse comment on the tuning of the instrument will immediately lead to vigorous testing of the octaves.

Table 1. Tuning values (calculated with the aid of tables in Young[2]) of an 8-stringed Ganda harp

Number of string	Frequency in cycles per sec.	Interval in Cents
1	405·82	
		250
2	351·25	
		245
3	304·90	
		244
4	264·82	
		235
5	231·20	
		238
6	201·51	
		236
7	175·83	
		239
8	153·16	

Tuning values. It will be seen from Table 1 that all seven steps are equal within a margin of 15 Cents. Mr. Mukasa did not always produce such regular intervals. On one occasion he tuned the first interval to 211 Cents and then corrected it to 227 Cents. On another occasion he produced an interval of 275 Cents for the second step, followed by 212 Cents to compensate for this excess and to fit the series into the framework of the octaves; he carried on with 252, 240, 228 and 245 Cents for the remaining intervals of the tuning. In one series of ten tunings, performed within one week, the mean for each of the seven intervals was remarkably close to 240 Cents (see Table 2). In the majority of unsatisfactory tunings, adjustments were made in the direction of this interval.

Table 2. Mean averages of ten tuning values of a Ganda harp

Interval between strings	Interval in Cents	
	Mean	± σ
1–2	239	15
2–3	254	17
3–4	238	12
4–5	240	8
5–6	236	10
6–7	240	11
7–8	229	14

Discussion. The preponderance of intervals of the type described in Table 1 is characteristic for harp and xylophone music in the kingdom of Buganda, an interval puzzling for a European ear inclined to interpret this strange pattern in more familiar terms of seconds and minor thirds.

The Uganda harp is usually played at such speed that no time is left for the sensation of chords and 'harmony'. Thus the kind of equal-stepped tuning observed need not create displeasure. It is noteworthy that the one exception where chords are struck is the octave, the only consonant interval in this system, which is also significant in European music.

In view of the care taken in tuning octaves, a European student might be tempted to expect some interest in fifths and fourths. However, the tuner pays no attention to them—unless the second tuning operation described above actually aims at fourths: two successive intervals in Table 1 may be said to suggest the interval of a fourth.

The same approach to tuning has been found in xylophone music in Uganda. Not only did the musicians show no response to the suggestion that their tuning might distinguish between intervals of different size, but also they clearly stated that they wished all steps to be the same.

It has been said that "the African is not thinking in terms of scales and intervals"[3]. One may well ask whether the equal-stepped tuning may not be due to this vacuum in the African musical mind, and whether it is possible that (*a*) when there is lack of concern in scales and chords, an equal-stepped pattern may emerge from a haphazard series of notes; (*b*) such a pattern might appeal to people in whose melodies the interval of the fourth is prominent.

This work was supported by the Colonial Social Science Research Council (Colonial Welfare and Development Scheme for Music Research R/233).

K. P. WACHSMANN

Uganda Museum,
Kampala.
Aug. 6.

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[1] Young, R. W., and Loomis, A., *J. Acous. Soc. Amer.*, **10**, 112 (1938).

[2] Young, R. W., "A Table relating Frequency to Cents" (C. G. Conn, Elkhart, Indiana, 1939).

[3] Howes, F., "Man, Mind and Music", 11 (Secker and Warburg, London, 1948).

FORTHCOMING EVENTS

Monday, January 9

Institution of the Rubber Industry, Midland Section (at the James Watt Institute, Great Charles Street, Birmingham), at 7 p.m.—Dr. C. F. Flint: "The National College of Rubber Technology".

Tuesday, January 10

Society of Dairy Technology (at the Conway Hall, Red Lion Square. London, W.C.1), at 10.30 a.m.—Mr. E. Capstick: "The Past 100 Years"; at 2.30 p.m.—Mr. Ben Hinds: "The Road Ahead".

Royal Anthropological Institute (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 5 p.m.—Prof. W. C Osman Hill. "The Veddahs of Ceylon, their Physique and Environment".

Institution of Electrical Engineers, Education Discussion Circle (at Savoy Place, Victoria Embankment, London, W.C 2), at 6 p.m.—Discussion on "The Organization of Laboratory Work" (to be opened by Mr. J G. Fleming).

Institution of Office Managers, Merseyside Branch (at the Exchange Hotel, Liverpool), at 6.30 p.m.—Mr. W. J. Jolly: "Quality Control".

Wednesday, January 11

Society for Applied Bacteriology (at the Medical Society of London, 11 Chandos Street, Cavendish Square, London, W.1), at 10 a.m.—Winter Meeting; at 2.15 p.m. (joint meeting with the Microbiological Panel of the Food Group of the Society of Chemical Industry).—Discussion on "The Hygiene of the Preparation and Service of Food".

Institute of Fuel, North-Western Section (at the Engineers' Club, Albert Square, Manchester), at 2 p.m.—Mr. A. Ridings: "Considerations affecting the Choice and Design of Boiler Plant".

Geological Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. J. E. Prentice: "The Carboniferous Limestone in the Manifold Valley, North Staffordshire"; Mr. A. Ludford: "The Stratigraphy of the Carboniferous Rocks of the Weaver Hills District, North Staffordshire".

Royal Microscopical Society (in the Hastings Hall, B.M.A. House, Tavistock Square, London, W.C.1), at 6 p.m.—Dr. Vera Fretter: "Minute Gastropods, Free Living and Parasitic".

Chemical Society, Eire Section (in the Department of Chemistry, University College, Dublin), at 7.45 p.m.—Prof. E. R. H. Jones: "Some Problems in the Chemistry of Vitamin D".

Institution of the Rubber Industry, West of England Section (at the George Hotel, Trowbridge), at 7.45 p.m.—Mr. Geo. Martin: "Developments in the Plantation Industry".

Thursday, January 12

Chemical Society, St. Andrews and Dundee Section (in the Chemistry Department, University College, Dundee), at 5 p.m.—Mr. R. P. Bell, F.R.S.: "Keto-Enol Equilibrium".

Royal Society of Arts, India, Pakistan and Burma Section (at John Adam Street, Adelphi, London, W.C.2), at 5.15 p.m.—Mr. H. W. Tilman: "The Mountains of Sinkiang—Travels beyond the Himalaya in 1948".

Institution of Electrical Engineers (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. J. E. N. Hooper and Mr. A. A. Kippax: "Radar Echoes from Precipitation". (Members of the Royal Meteorological Society are invited.)

Illuminating Engineering Society, Manchester Centre (joint meeting with the Manchester Area Branch of the Electrical Contractors' Association, in the Reynolds Hall, College of Technology, Manchester), at 6 p.m.—Mr. F. G. Copland: "Analysis of Lighting Problems in an Industrial Undertaking".

Pharmaceutical Society (at 17 Bloomsbury Square, London, W.C.1), at 7.30 p.m.—Dr. J. M. Rowson: "Genetics, Cultivation and Pharmacognosy".

Friday, January 13

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

Institution of Electrical Engineers, Western Centre and West Wales (Swansea) Sub-Centre (at the Brangwyn Hall, Swansea), at 6.30 p.m.—Dr. R. A. Smith: "Radar" (Faraday Lecture).

Institution of Works Managers, Manchester Branch (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Miss Joan Woodward: "Some Problems of the Physical and Psychological Environment of Work".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Advisory Officer in Grassland Husbandry, a Research Assistant in Milk Utilization, and a Technical Assistant to the Advisory Officer in Animal Husbandry—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow, C.2 (January 14).

Senior Lecturer in Electronic Engineering or Research Fellow in the Department of Electrical Engineering, University of Adelaide—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (January 16).

Chemist (Senior Scientific Officer or Scientific Officer grade) and a Chemist (Senior Experimental Officer or Experimental Officer grade) at a Ministry of Supply research and development establishment in London for work on safety measures and other research problems connected with industrial use of explosives and high pressure acetylene—The Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.883/49A (January 21).

Assistant Lecturer in Paper Making—The Registrar, College of Technology, Manchester 1 (January 23).

Senior Veterinary Officer at the Institute of Medical and Veterinary Science, Adelaide—The Agent General and Trade Commissioner for South Australia, Marble Arch, London, W.1 (January 23).

Principal Geologist at the Central Directorate of the Colonial Geological Surveys, Imperial Institute—The Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting G.422/49A (January 28).

Laboratory Manager of the John Curtin School of Medical Research, Canberra—The Administrative Officer in the U.K., Australian National University (London Office), 6 Gordon Square, London, W.C.1 (January 31).

Research Assistant to the Professor of Colour Chemistry and Dyeing—The Registrar, The University, Leeds (January 31).

Scientist (Grade III) in the Directorate of Scientific Control, to carry out operational research—The National Coal Board, Establishments (General) Branch, Hobart House, Grosvenor Place, London, S.W.1, endorsed TT/180 (January 31).

Chair of Aeronautical Engineering, and a Head of the Engineering Department and Professor of Mechanical Engineering—The Registrar, University College, Southampton (January 31).

Lecturer in Geography—The Registrar, The University, Reading (February 1).

Lecturer or Assistant Lecturer in Chemistry at the University College of the West Indies—The Secretary, Inter-University Council for Higher Education in the West Indies, 1 Gordon Square, London, W.C.1 (February 11).

Senior Lecturer in Agricultural or Chemical Microbiology at the University of Melbourne—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (February 11).

Senior Lecturer in Bacteriology at University College, Ibadan—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (February 11).

Chair of Agriculture in the University of Ceylon—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (February 15).

Physicists (Scientific Officer grade) at Ministry of Supply Research and Development Establishments in Southern England and South Midlands—The Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.325/49A (February 20).

Professor of Agriculture—The Secretary, Imperial College of Tropical Agriculture, 40 Norfolk Street, London, W.C.2, or The Registrar, Imperial College of Tropical Agriculture, St. Augustine, Trinidad, B.W.I. (March 31).

Entomologist for the Malaria Service of the Medical Department, Nigeria—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

Plant Physiologist to carry out research work on natural rubber latex—The Director of Research, British Rubber Producers' Research Association, 48 Tewin Road, Welwyn Garden City, Herts.

Research Assistant (preferably A.R.I.C. standard) to work on the analysis of a wide range of non-ferrous alloys, including development of new analytical methods, and a Physicist to work on spectrographic analysis of metals—The Secretary, British Non-Ferrous Metals Research Association, 81–91 Euston Street, London, N.W.1.

Research Technician to assist in experiments connected with the origin and treatment of cancer—The Dean, Guy's Hospital Medical School, London, S.E.1

Senior Entomologist and a Junior Entomologist (with good honours degree in Zoology) for entomological research with special reference to East African conditions, and a Research Officer for spectrographic work on soils and plant materials, in the East African Agriculture and Forestry Research Organization—The Under-Secretary of State, Colonial Office (Research Department), Sanctuary Buildings, Great Smith Street, London, S.W.1.

Soil Physicist in the Department of Agriculture, Sierra Leone, for investigations in connexion with the reclamation, drainage and cultivation of paddy rice on very acid soil—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London. S.W.1.

Lecturer in Mathematics—The Clerk to the Governing Body, Battersea Polytechnic, Battersea, London, S.W.11.

Research Physicists—The Secretary, Research Association of British Rubber Manufacturers, 105 Lansdowne Road, Croydon, Surrey.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

University of Leeds. Thirty-sixth Report, 1946–47. Pp. 34. Thirty-seventh Report, 1947–48. Pp. 39. (Leeds: The University, 1948–1949.) [3110

Scottish Home Department: Fisheries Division. Scientific Investigations, 1949, No. 1: The Distribution of Thaliacea (Salps and Doliolids) in Scottish Waters, 1920 to 1939. By Dr. James H. Fraser. Pp. 44. (Edinburgh and London: H.M. Stationery Office, 1949.) 2*s*. net. [3110

Department of Scientific and Industrial Research. Index to the Literature of Food Investigation. Vol. 17, No. 2, September 1945. Compiled by Agnes Elisabeth Glennie. Pp. iv+105–181. (London: H.M. Stationery Office, 1949.) 6*s*. net. [3110

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GEOLOGY IN SCHOOLS AND UNIVERSITIES

THE practical value of geology to the community has been realized by government departments and by industry to an increasing extent during and since the War. As a consequence, until quite recently the demand in Britain for geologists has exceeded the supply. The publication by the Technical and Scientific Register branch of the Ministry of Labour of a pamphlet* that discusses the future demand for geologists is therefore timely. The booklet forms one of a series, published or in preparation, dealing with a number of the scientific and technical professions. Lord Hankey, chairman of the Technical Personnel Committee responsible for these publications, expresses, in a general foreword, the hope that the reports will be of use to universities, schools, professional bodies and other authorities concerned with the recruitment, education and training of future members of these professions.

The report on geology has been compiled by a sub-committee which included the directors of the Geological Surveys of Great Britain and the Colonies, after studying the evidence presented by representatives of the schools, universities, professional bodies and selected industries.

The main conclusions and recommendations are that, in general, the demand for geologists as such, either at home or abroad, is likely to be entirely confined to really good men of first- or second-class honours standard; and most geologists who qualify will have to find posts overseas, for which a further essential qualification is the passing of a rigorous medical examination. The demands for geologists in Britain—for the Geological Survey and the staffs of British universities—will be appreciably smaller than for the overseas posts. Opportunities for less highly qualified geologists will probably be few, apart from such as are absorbed by the Geological Survey in Great Britain in the grade of assistant experimental officer.

In the matter of training, the Committee states that the unanimous view of those who gave evidence was that a complete course in pure geology is essential for the training of a professional geologist, and that specialization should follow such a course, generally through postgraduate study. The importance of a knowledge of geophysics was stressed by a number of the representatives of 'user' interests.

It was pointed out that the supply of geologists before the War (presumably of those intending to make geology a career) was of the order of only twenty per annum, but that the number will be much greater in the next two or three years, the estimates being 127 for 1948, 112 for 1949 and 140 for 1950. Of these, it was suggested, perhaps some 60 per cent will obtain a good honours degree. On this basis, and from the evidence submitted to the Committee, the estimated supply up to 1952 is given as 76 in 1948, 67 in 1949 and 84 in the three remaining years of the period. The estimated demand for the Geological Survey of Great Britain is 10 annually, for Colonial Geological Surveys 27, 36, 33, 21 and 12, for oil geology 20 annually, for mining geology 30 in 1948 and 7 annually afterwards, and for the universities 6 annually. Thus the estimated demand would overtake the probable supply by 1950, and would exceed it substantially (84 available to 55 required) in 1952. It is also noted: (1) a part of the demand for oil geologists will be met from the Dominions; (2) in addition, there will be a very small demand amounting in all to 5–10 annually from technical colleges and schools, museums, other government departments, etc., and industry (other than oil and mining). That the figures for 1948 are only 'estimated' is explained by the fact that the report is dated August 1948, and it is surprising that publication should have been delayed until December 1949.

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* Ministry of Labour and National Service: Technical and Scientific Register. Present and Future Supply and Demand for Persons with Professional Qualifications in Geology. Pp. 16. (London: His Majesty's Stationery Office, 1949.) 4d. net.

The specific terms of reference of the Geologists' Sub-Committee are not stated; but the report, brief as it is, has succeeded in achieving its main object in providing useful guidance, so far as the immediate future is concerned, to those concerned with the recruitment and training of professional geologists for the specific fields mentioned above.

Looking to a slightly more distant future, however, one cannot help wondering what the ultimate effect of this report may be. Within a day or two of publication, reports in this series were being purchased by students themselves, and it seems not unreasonable to suppose that to a young student who reads that few but good honours graduates could expect to obtain employment as professional geologists, and that from 1950 onwards the supply is expected to exceed the demand, the report would quickly repress any aspirations he may have had for geology as a career. In these strenuous days, it is the career value of a subject that most students must of necessity consider first; and it is difficult to suggest, on the basis of this report, that any educational adviser could do other than point out that, very soon, the demand in Great Britain for geologists is likely to fall considerably below the supply.

Geology is taught as a separate subject in very few schools in Britain; and if a student becomes aware of it as a possible degree subject before proceeding to a university, it may only be by chance, perhaps as a result of learning about it from a teacher of geography who has a personal interest in the subject. Therefore, a student may arrive in a university with a good basic knowledge of chemistry, physics, mathematics, botany and, not infrequently, zoology—but very rarely geology. One might therefore have hoped that the newly published booklet would have indicated to teachers and senior scholars what advantages geology had to offer when studied as a subject for a general degree course. It may, for example, be taken with advantage by those who propose to follow advanced courses in archæology, forestry or town planning; and how often, one may ask, does a student whose special bent is mathematics or physics have it pointed out to him that such subjects might be usefully combined with geology, with the view of a career in geophysics? As already mentioned, the importance of a knowledge of geophysics is stressed by the report.

It therefore seems that an opportunity has been missed, in omitting from this report any reference to the value of geology as a subsidiary subject in a number of careers. Moreover, the openings in geology for women are not indicated. Women are, for example, eligible for appointments in the Civil Service as assistant experimental officers, and a number with geological qualifications have already been appointed to such posts.

It is to be feared that one of the results of this report may be to warn off all but the most enthusiastic from geology as a career, and even reduce the supply in the not very distant future to a level below the demand. It would be unfortunate if its effect were to push geology back again into the position of being the Cinderella of the sciences in the educational system of Britain, a position from which it has only in recent years shown signs of emerging. Perhaps in future editions of this pamphlet additions might be made indicating the possibilities for those who, although they may not make geology their principal life-work, nevertheless would find a knowledge of it of value to them both professionally and culturally.

MAN STUDIES HIMSELF

Personality

In Nature, Society and Culture. Edited by Clyde Kluckhohn and Henry A. Murray. Pp. xxi+561+x. (London: Jonathan Cape, Ltd., 1949.) 30s. net.

THIS is a kind of anthology, except that perhaps it would be an exaggeration to say that the items of the collection are chosen for their beauty. There are so many of them—thirty-eight in a book of 561 pages—that it is next to impossible to give a brief description of their contents, and almost as difficult to say what, if anything, they all amount to. It is true enough to say that they are all concerned with some characteristic, general or specific, of the relation between man as an individual and men as they are organised into a form of society, and that, with some exceptions, this is not regarded simply as an opposing relationship, but as one in which each side draws from the other many things which give it ultimately an appearance of permanent structure.

The editors, who are already well known for earlier and, in many quarters, highly approved studies of human personality, preface the whole by a rather abstract and difficult essay. This eventually arrives at the statement: "Personality is the continuity of functional forces and forms manifested through sequences of organised regnant processes in the brain from birth to death". It seems as if this ought to mean that personality is what it does. But if we are left with the impression, as we may well be if we succeed in reading and accepting the whole of this large volume, that it does anything and everything according to occasion and opportunity, then such an assertion does not perhaps help very much. Indeed, however, the case is not so bad, or so simple as all this. For, no matter what may be the diversity of occasion and opportunity, personality can be regarded as operating according to a certain limited number of principles.

The key idea, which seems to have almost an obsessive force in much current American writing about men in society, is the 'reduction of tensions'. 'Tension' may seem as if it is a perfectly objective term. But, in point of fact, in this context it always tends to appear as some form of felt discomfort, or as disappointment actually experienced or psychologically anticipated. So the basic effort is always one of avoidance; but avoidance may take peculiar forms, so that it sometimes appears not as a mechanism of escape but as one of achievement. Either way, the devices that can be adopted are limited. A man may, for example, go to sleep; personality allows "for the periodic regeneration of energies by sleep". But, whether fortunately or unfortunately it is not stated, nobody can sleep all the time except in fairy tales. So he can elect to reduce himself to a sort of semi-comatose permanent state by "restricting the number and lowering the level of goals to be attained". If he does, he becomes presumably one of those whom Confucius called "the good, comfortable people of the villages". Or he can admit his discomforts but postpone their resolution to some distant and unknown date and clime, and then he may become a tolerably happy idealist, with or without religion, accepting the knocks of terrestrial fortune as the price of future bliss; or he may disapprove everybody else in a persistent course of approving himself. Again, he may "design serial programmes for the attainment of distant goals", and "follow schedules which result in a harmonious way of life". Then, he is the person who comes to let the generality of the rule swallow up the bitterness of the particular example. Finally, he may "reduce conflicts between personal dispositions and social sanctions . . . by a series of compromise formations, the trend of which is towards an emotional identification with both the conserving and the creating forces of society".

Whatever may be thought of all this from other points of view, it certainly presents an excellent scheme for a book. In all its varieties human personality is seen as a process of formation which can be followed through a set of nice, tidy categories. It starts, develops, becomes more or less stereotyped and then, perhaps, declines. These are successive stages, and we can take each stage in turn, and try to discover what are the main conditions operating in a sufficient number and diversity of concrete settings. The descriptive results may take any of the forms set out in the scheme; but the rules of operation of the conditions may be found constant for all the forms. This is what the book endeavours to show, by presenting single selected chapters from the specific researches of the thirty-eight writers represented, with brief introductory remarks by the editors.

The crux of the whole matter is really the starting-point. It has to be supposed that both individual and society possess a constitutional structure, for without this there seems to be no good reason why either should develop that relatively permanent form called personality. The individual constitution is said to be a blend of genetical, physical and physiological, psychosomatic and psychological elements. None of these, especially the psychosomatic, is very clearly defined. The psychological elements are said to be extremely persistent modes of perceiving, recognizing, recalling and, in general, of carrying out the "higher mental functions"; but no specific evidence is given for them in the constitutional section, though this might be attempted.

The elements of social constitution are not stated. Perhaps it is left to be assumed that they are the same elements but blended in a much more complex fashion, because the unit is an organised population and not simply a number of persons each with his own body. But this does not seem to be correct, for in almost all the succeeding discussions the social contribution to individual personality formation appears to be made through items, or clusters of items, of a specifically social possession called "culture"; and "culture" is not—and perhaps cannot be—presented as a blend of the individual constitutional elements. There is a troublesome gap here.

Having achieved this basic expository scheme, of an individual with a constitution and a society with culture, the book goes on to illustrate the influence of culture upon constitution in particular instances of the former. There are some influences which a society exerts upon all its members; these are called "group membership determinants". There are others which it exerts only upon those of its members who have particular positions and functions; these are called "role determinants". There are still others which it exerts upon all or some through particular situations; these are called "situational determinants". Finally, there are cases in which all or some of these influences are combined; these are called "inter-related determinants".

Much of this extracted material is intensely interesting. But it is so diversified and covers so many specialized communities that only a person of encyclopædic range could form a fair opinion of the reliability of the evidence given and the justification of the conclusions drawn. Moreover, all that appears to be achieved is a series of more or less apt illustrations of the original thesis.

Many readers are likely to agree that there is much in the book which shows that there are plenty of aspects of human social behaviour which can be scientifically studied, given a concrete setting. More still are likely to agree that the general theory which the editors advance is not itself demonstrated in a scientific manner, and that by this type of approach it never could be.

F. C. BARTLETT

COLORIMETRY IN CHEMICAL ANALYSIS

Colorimetric Methods of Analysis

Including some Turbidimetric and Nephelometric Methods. By Dr. Foster Dee Snell and Dr. Cornelia T. Snell. Third edition. Vol. 1: Theory—Instruments—pH. Pp. xii+239. (New York: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1948.) 25*s.* net.

SINCE the publication of the second edition of this work ten years ago, colorimetric analysis has become much more widely used. During this interval many suitable instruments have become available, and knowledge of the importance of trace elements in human food and fodder for cattle, contaminants in metals, etc., has greatly increased. Original contributions to the literature on the subject of colorimetry have been on a very large scale, covering such a wide range of subjects as biology, nutrition, drugs, metallurgy and instrument design. The present volume deals with the theory of colorimetric methods a description of the instruments used and methods of determining hydrogen-ion concentration.

The number of references to the scientific literature is truly remarkable and may in some cases prove an embarrassment to the reader, as the authors of the volume cannot deal critically with, and summarize adequately, such a mass of information. The volume is profusely illustrated, contains many useful tabulated data, and is well printed and reasonably free from errors. Page 63 in the review copy forms an exception, since the letter *t* is missing in consecutive words, and the number of different gradations of colour which the human eye can detect is given as about 10,000, which appears to be a misprint for Judd and Kelly's estimate of 10,000,000. The authors have described and illustrated a comprehensive selection of instruments used in colorimetry, which should enable the reader to choose one suitable for any purpose. Information on the spectral response of commercial barrier-layer and photo-emissive cells used in many of these instruments would have been useful, as well as some account of cell fatigue. Most readers would prefer working diagrams rather than so many pictorial illustrations which are readily available in catalogues. While many of the schematic diagrams are excellent, that of the Hardy colorimeter omits some essential details, and diagrams of some of the well-known spectrophotometers are omitted altogether.

It is to be regretted that the authors consider that photo-electric tri-stimulus colorimetry is outside the field of colorimetric analysis. No text-book written mainly for chemists has yet dealt with this subject, in spite of its importance in the measurement of the colour of paints, pigments, inks, signal glasses, etc. Two colorimeters mentioned in the volume, namely, the Hardy and the Lovibond–Schofield, are capable of being used for the measurement of colour in terms of the system of the Commission Internationale de l'Eclairage, the internationally accepted method of colour expression. The chapter devoted to the characteristics of colour filters gives information difficult to obtain elsewhere, although more diagrams correlating transmittancy with wave-length, or tables giving percentage transmission at various wave-lengths, would have been useful. The use of fluorimetry in analysis is limited to a description of the instruments employed. The subject has assumed increasing importance in recent years in its application to the estimation of aneurine and riboflavine, and many readers would have appreciated more information on the essential theory and the difficulties in obtaining reliable measurements due to quenching, etc.

Much useful information is given in the section devoted to accuracy, which is well worth careful study by even practised workers in colorimetry. Some modification is desirable in the statement "It is usually easier to distinguish between two colours than between colorless and colored". Sandell, in his book "Colorimetric Determination of Traces of Metals", is in difficulty on this point, whereas the advocates of the so-called achromatic indicators are opposed to Snells's statement. The use of indicators for the measurement of hydrogen-ion concentration is dealt with very fully, and with a wealth of practical details to be observed when dealing with food products and biological specimens. Workers in these fields who are not physical chemists would be well advised to study this section carefully before embarking on measurements of the *p*H of their specimens. Readers unfamiliar with the terms used would have appreciated definitions at an early stage; for example, the significance of the isobestic point in the transmission curves of indicators is not explained, and the definition of the isohydric points of indicator solutions is considerably delayed. Neither term can be found in the index.

This revised and enlarged edition with its numerous references is a valuable addition to the literature on colorimetry and will be welcomed by all workers using colorimetric methods of analysis.

JOHN KING

GREEK CONTRIBUTIONS TO MATHEMATICS AND SCIENCE

A Source Book in Greek Science

By Dr. Morris R. Cohen and Dr. I. E. Drabkin. (Source Books in the History of the Sciences.) Pp. xxi+579. (New York and London: McGraw-Hill Book Co., Inc., 1948.) 54*s*.

"THE notion that natural science began in the seventeenth century with Bacon, Galileo, and Descartes, or perhaps in the sixteenth with Copernicus, and that the Greeks were mere speculators and the medieval thinkers all sunk in theology and superstition," state the compilers of this work, "is not merely an established popular error; it has become a basic dogma of modernistic philosophy and is even shared by professional historians. This error is largely supported by the prevailing type of specialized education, which trains students of nature to look at things exclusively from the point of view of current conceptions and does not sufficiently equip them with philological or historical methods to investigate how the world appeared to man at other times. On the other hand, historians trained in the humanistic tradition often fail to discriminate justly between genuine science and folklore. In any event, the scientist's interest in the nature of things and the historian's interest in the development of man's critical knowledge are all too seldom united. Such a union of interests, however, can be furthered by the study of the history of science. It is to serve this study that the present series of Source Books was inaugurated."

So far, source books in astronomy, mathematics, physics and geology have appeared in the series and have established a place for themselves; and there are few who would dispute the worthiness of the objective aimed at. For in the twenty years that have elapsed since the first volume was published, the education of the man of science has become increasingly specialized, which is to say narrowed; and often vocational training, admittedly in disguise, has encroached perilously upon learning. It is a sobering and indeed a frightening reflexion that teachers still active may, if this trend is not arrested, be faced before they reach the brink of their academic demise with a generation of undergraduates in science inspired with the faith that what is not in the syllabus is not in Nature. The remedy of prescribing wider studies in his own field in order to broaden a student's outlook is worse than the disease, which it aggravates; for it robs him of a leisure that he might put to better purposes. Happily, it is now becoming widely realized that the history of science can provide the humanistic element in scientific education; for, even if only a minority of science students are interested in the general history of science, almost all are interested in the history of the science in which they are specializing.

This series of books, each with extracts from the classic works and memoirs of the founders of science, has given the student what he really needs in a handy and easily accessible form. The latest addition, a source book in Greek science, may well prove the most useful, not only to the student, but also to the general reader. The editors have cast their net widely and gathered almost six hundred pages of extracts with explanatory notes on mathematics, astronomy, mathematical geography, physics, chemistry and chemical technology, geology and meteorology, biology, medicine and physiological psychology. A detailed table of contents allows the reader to find quickly any topic in which he is interested in a period covering about a thousand years. There is at the end a valuable classified list of some important works on Greek science.

The section on chemistry and chemical technology includes translations from the Leyden Papyrus X and the Stockholm Papyrus, both of which may be described as 'Greek' only because they were written in that language, their content being derived from ancient Egypt; the translations made by Berthelot are more satisfactory than those quoted here.

It is a vast canvas, on which the contribution of the Greeks to mathematics stands out above all their other scientific activities; the reader soon appreciates how little understanding they had of experimental science and how far they are from us in that respect.

D. McKie

PHOTOGRAPHIC EMULSIONS FOR RECORDING NUCLEAR PARTICLES

Radioactive Measurements with Nuclear Emulsions
By Herman Yagoda. Pp. ix+356. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1949.) 30*s*. net.

THE photographic (silver halide) emulsion has now been fully established as a tool as useful as the Wilson cloud chamber, ionization chamber, or Geiger counter in nuclear physics and radioactive studies, with the added advantage of simplicity, continuous sensitivity and permanent recording of the tracks of individual particles. Progress in the use of silver halide emulsions has been particularly rapid within the last few years, and there should be a demand, therefore, for a book which deals with the properties and limitations of the emulsion, together with a description of the numerous applications already devised.

Dr. H. Yagoda has attempted such a book and has collected together in one volume a large mass of experimental data, chiefly on the use of silver halide emulsions as alpha-particle or beta-particle detectors in radiochemistry, mineralogy, metallurgy, crystallography and biology, and the chapters on these subjects should prove very useful to anyone contemplating working, or already engaged in work, in these fields. Emphasis is on the experimental technique, and methods for producing suitable flat specimens are described in detail. The book has been designed primarily as a guide to the use of emulsions in radioactive measurements and provides an extensive survey of work in the above-mentioned fields, the bibliography alone including more than six hundred references. The final section of the book is a fairly brief survey of experimental techniques and results obtained with emulsions in nuclear physics.

The book loses much of its value, however, by the way in which the emulsion data and theoretical material are presented. These are scattered rather at haphazard throughout the book, sometimes under very misleading chapter headings. One would scarcely class, for example, the chemical reactions of emulsions with hydrogen sulphide or metals, and the effect of pressure, important as a knowledge of such effects is in order to prevent misleading interpretations of autoradiographs, under the general heading of "Photographic Detection of Nuclear Particles". The general properties of emulsions are described in Chapter 4, under the main heading of "Alpha Particle Patterns in Nuclear Emulsions". The most detailed description in the book of a nuclear emulsion is given on p. 255, which is somewhat delayed, considering the title of the book. Only the main chapter headings are given in the list of contents, and, as these headings are often vague, one has to rely on the index to look up any specific information; but owing to the scattering of related information throughout the book this process is not easy.

A knowledge of the dependence of the ionizing power of a particle on its velocity and charge, the range – energy relationships for the various types of particle in emulsions, and the variation in ionizing power along the path of a particle, together with the fact that silver halide grains in an emulsion can differ in size, sensitivity, concentration per unit volume and development-rate (fog), is essential in order to obtain a clear picture of why a particle may or may not give a recognizable track in a particular emulsion. Only by such an approach can the future applications of emulsions and their possible limitations be fully recognized. This does not seem to have been clearly realized by the author, with the result that the theoretical parts of the book tend to present a confused picture. Descriptions such as that which occurs on p. 249, where it is stated that the photographic action of gamma-radiation is due to the formation of secondary electrons in the sensitive film, and that the efficiency of this process is low, are also confusing. It is not the efficiency of the process which is low but the absorption of the gamma-rays. The expressions "photographic action of gamma rays" and "photographic action of beta-particles" (see p. 223) are in themselves misleading.

This sort of treatment leads to the arbitrary distinctions made between alpha- and beta-autoradiography, and between 'nuclear' and 'optical' types of emulsion. Emulsions utilize silver halide as the sensitive material, and the sharp division which is implied between 'nuclear' and 'optical' types is entirely artificial.

This book is the first of its kind and, in spite of the above criticisms, can be recommended as a survey of work already carried out with silver halide emulsions in radioactive studies; but it is suggested that it should be read in conjunction with a sound exposition of the properties and characteristics of emulsions when exposed to nuclear particles, such as that given by Webb in the *Physical Review* (**74**, 511; 1948).

R. W. Berriman

Chemical Activities of Fungi

By Prof. Jackson W. Foster. Pp. xviii+648. (New York: Academic Press, Inc.; London: H. K. Lewis and Co., Ltd., 1949.) 9.50 dollars.

THE author of this book, who is professor of bacteriology in the University of Texas, defines its purpose as "to stress the subject matter from the standpoint of dynamics, that is, *transformations* [author's italics] effected by fungi". He states that it is designed primarily for the beginning student "with an eye toward the use of this book as a text for college courses at the upper-class or graduate level". He excuses his admitted omission of large and important aspects of the chemical activities of fungi by saying "it was done advisedly to keep the size of the book within bounds".

The nineteen chapters of the book contain the following headings: 1, introduction, history, perspective; 2, the methodology of mould metabolism; 3, chemical nature of the mould mycelium; 4, general considerations of mould metabolism; 5, natural variations; 6, mutations, physiological genetics, and biochemical syntheses; 7, trace element nutrition of fungi; 8, lactic acid formation by fungi; 9, alcoholic fermentation by moulds; 10, oxalic acid metabolism; 11, fumaric and other C_4-dicarboxylic acids; 12, citric acid; 13, itaconic acid; 14, kojic acid; 15, gluconic and other sugar acids; 16, carbohydrates produced by fungi; 17, nitrogen metabolism of fungi; 18, other transformations in fungi; 19, microbiological aspects of penicillin. The title of the book is inaccurate, misleading and too comprehensive. Little reference is made to modern work on mould metabolic products which have been described during the past twenty years and many of which have pronounced antibiotic properties. Most attention is paid, as will be clear from the contents, to the numerous theories, often mutually contradictory, of the mechanism of formation of a small number of old-established mould metabolic products. Further, there is little reference to any of the higher fungi, the subject-matter being confined almost exclusively to moulds.

Deserts on the March

By Paul B. Sears. Pp. xi+181. (London: Routledge and Kegan Paul, Ltd., 1949.) 10*s.* 6*d.* net.

ALL but the last chapter of this book was written and printed in 1935, in the dark days in the United States after the 'famine years' of 1933 and 1934 had directed the urgent attention of the whole nation to the dangers of soil erosion. Later the problem was pushed into the background by the urgency of the War; now once again it is being appreciated as one of the great problems of human survival. Dr. P. B. Sears is professor of botany at Oberlin, Ohio, and he presents the picture with a greater scientific accuracy, a more pleasantly moving narrative and avoidance of the dangerous sensationalism of other writers.

Nevertheless, it is curious that he regards the natural cycle of erosion as destructive rather than one which balances construction with destruction. He seems also to regard man as everywhere destructive, failing to appreciate those areas where man has built up the soil. He regards the modern Italian as one of the best farmers in the world (p. 22) and rates highly European farming generally; yet he does not seem to draw the obvious deduction that a balanced mixed farming with the integration of crops and grass provides the answer he seeks. It is curious to find the acceptance of 150 million (to be reached in 1960) as the maximum population the United States can support, and sixteen acres of land per head (including three of ploughland) a minimum to maintain the American standard of living. We see here the still amazing contrast between the points of view of Great Britain and America, with the former having at present 1·2 acres (0·25 of ploughland) per head on which it is attempting to maintain its standard. It would be well to read Sir John Russell's presidential address to the British Association (see *Nature*, September 3, 1949, p. 379) side by side with this book.

Dr. Sears's remedy to secure good farming is to use taxation as both an incentive and a punishment —a solution of no little interest at the present time.

L. DUDLEY STAMP

Brochure on Penicillin

By Dr. S. L. Bhatia. Pp. 171. (Ludhiana: Dr. S. L. Bhatia, Government College, 1949.) 1.8 rupees.

THIS is the second volume of the Indian Science Series, which seeks to give, in language which the non-specialist can understand, basic facts about progress in science and industry. After an introduction which briefly summarizes the chief conditions required for the production of penicillin, the author gives, in simple English words, an account of its discovery and its development during and after the Second World War. A description follows of the methods used for its manufacture on a large scale, and the author then discusses the characteristics of penicillin, its standardization and its pharmacological uses. A chapter on its marketing and storage precedes an appendix which discusses some recent developments. A list of references and an index complete a volume which many, who have no expert knowledge of penicillin, will find useful and interesting to read. The copy received lacks the illustration of penicillin crystals mentioned in the list of illustrations. The author believes that "the responsibility for the development and application of science in a democratic country rests ultimately with its citizens", and his aim has been to place, at a small cost, the knowledge of penicillin at the disposal of laymen, manufacturers, students and any others whom it may interest. He is to be congratulated on the production of this clear and very readable little book.

Organic Syntheses

An Annual Publication of Satisfactory Methods for the Preparation of Organic Chemicals. Vol. 28. Pp. vi+121. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1948.) 15*s.* net.

THIS welcome annual continues to render valuable service to organic chemists seeking reliable methods for preparing a large variety of substances. The current volume adds thirty-seven preparations to the lengthy list, and there is a cumulative subject index covering Volumes 20–28. This index, taken in conjunction with those in the first and second collective volumes of the series, enables a quick reference to be made to any specific substance for which details have been given. Among interesting substances in the issue under notice are *trans*-1,2-*cyclo*hexanediol, hexamethylene chlorohydrin, 2-hydroxycinchoninic acid, *p*-nitrophenyl sulphide, and vinyl chloroacetate. As usual, the processes are based in the main upon methods already given in chemical literature, and here adapted and improved by one set of workers and checked independently by others. British organic chemists might well contribute in greater measure to this admirable publication.

J. R.

A NEW APPROACH IN THE BIOCHEMISTRY OF GROWTH AND DEVELOPMENT

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A RECENT advance in our knowledge of the cell nucleus, of considerable interest in itself, promises in addition to become of major importance in the work of revealing the biochemical basis of growth and development. For some time it has been accepted that deoxyribonucleic acid is wholly confined to the cell nucleus in normal circumstances, and that it is one of the major components of the chromosomes. In 1948, Boivin, Vendrely and Vendrely[1] announced that they had found in the nuclei of somatic cells from animals of a single species constant amounts of this substance which were double those found in the corresponding haploid or sperm nuclei. These findings have since been confirmed and extended to a wider range of animals by Mirsky and Ris[2], and by Vendrely and Vendrely[3], whose latest work shows that the absolute values of deoxyribonucleic acid per nucleus fall within a compact group for a variety of mammalian species, and are appreciably different from those of, say, avian nuclei.

Thus we now have a nuclear component, which is a constant element of all normal cells of a given species and which lies at the centre of the metabolic life of the cells as part of the genes controlling their activities. In effect, it is a chemical unit which we can use as a measure of cell multiplication, and as a standard of reference by which we can reveal the changing metabolic patterns of cell activity in normal growth, differentiation, and the processes of regeneration and decay. The problems associated with growth are so extensive that it becomes necessary for the present to avoid a discussion in general terms, and to confine ourselves to the implications of the new approach as they appear in our first results of the chemical changes occurring both in embryo chick heart explants growing *in vitro*, and in tissues developing normally within the avian egg.

In biochemical studies of tissue-culture growth, we are first of all concerned with the measurement of the increases in the amounts of living material occurring under different experimental conditions. The methods available at present have been thoroughly reviewed by Cunningham and Kirk[4] who, finding them defective in one respect or another, proposed to measure culture growth by three parameters, the increase in cell number, the average change in cell size, and the volumes in which the cells existed at the various stages of growth. What we are proposing is in a sense the chemical counterpart of this method of analysing culture growth; and while it greatly simplifies the problem from the technical point of view, it does not, of course, eliminate the need for microscopical studies on the changing cell character or structure, which have been and will continue to be an important aspect of tissue-culture investigations.

The measurement of increasing cell number during growth in which the proportion of abnormal mitotic divisions is small or negligible now becomes a matter of determining quantitatively the changing deoxyribonucleic acid content of the cultures, using some such method as that of Schmidt and Thannhauser[5] for separating the ribonucleic acid from the deoxyribonucleic acid. The actual deoxyribonucleic acid (or ribonucleic acid) content can be based on the determination of the phosphorus present, or on measurements of the intensity of light absorption (at 257 mμ) due to the purine and pyrimidine components. The amounts of deoxyribonucleic acid then give us the relative increases in cell number with time, and if the actual amount of the acid per nucleus for the particular species in question is known, we can easily calculate the corresponding cell numbers. Table 1 shows the figures of cell increase, which have been obtained from chick heart explants growing *in vitro* over a period of six days. The calculation of cell number is based on the figure of $2 \cdot 62 \times 10^{-6}$ μgm. deoxyribonucleic acid per nucleus of the fowl erythrocyte found by Davidson and McIndoe[6], a figure which agrees closely with that of other workers, and which we must assume to be applicable to all the diploid somatic nuclei of the embryonic and adult organism. In this test we see that the cell number is doubled roughly every forty-eight hours over the last four days, a rate of multiplication which agrees with that found by Fischer[7] and others for the growth of chick heart fibroblasts in comparable conditions.

Table 1. Cell number in chick heart explants growing *in vitro*, based on deoxyribonucleic acid content of fowl nuclei as $2 \cdot 62 \times 10^{-6}$ μgm.

Growth-period (days)	Deoxyribonucleic acid (μgm.) per 48 explants	Calculated cell number × 10^6
0	7·00	2·7
2	8·50	3·2
4	18·40	7·0
6	35·70	13·6

In contrast to the differentiation of cells occurring in normal embryonic growth, the unorganised growth of cells in tissue cultures involves their reversion morphologically and biochemically to one of three main types[8]. Fischer[7] prefers to describe the process as one of dedifferentiation, in agreement with the conclusions arrived at by Olivo[9,10] in his studies on explanted heart tissue. It is fairly certain, then, that the growth of the chick heart explants used by us is accompanied by the 'dedifferentiation' of the myoblasts to a more primitive, or perhaps more generalized, type of cell. As we shall show later, there is at the same time a distinctive and regular pattern of chemical changes which may be related to their dedifferentiation. It is more usual, of course, in tissue-culture studies to work with pure strains of cells, in which complete reversion has been obtained by repeated sub-culturing. While the pattern of chemical changes in these will certainly be different from those occurring in our fresh explants, they will also have to be studied in relation to changes in growth-rate or in experimental conditions.

For these reasons we find it essential to investigate culture growth by recording two aspects of the process. The quantitative one, giving us an account of increasing cell number with time, has already been illustrated. For the second we use deoxyribonucleic acid as a standard of reference to reveal the changes in the relative amounts of other cell constituents. This gives us a view of the qualitative changes in

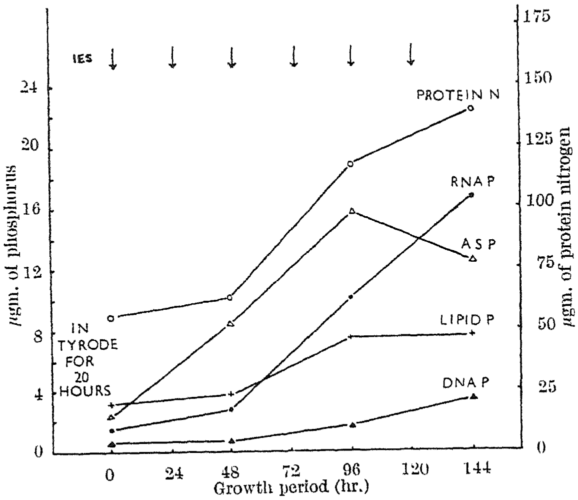

Fig. 1. Increases in chemical components of chick heart explants growing *in vitro* Incubated embryo extract + serum replaced by fresh lots every 24 hours. Results show content per roller tube of 48 cultures. *ASP*: acid-soluble (10 per cent trichloracetic acid) phosphorus; *RNAP*: ribonucleic acid phosphorus, *DNAP*: deoxyribonucleic acid phosphorus

cellular composition as the cultures develop and respond to varying experimental conditions. The actual values relative to deoxyribonucleic acid will, of course, represent the mean composition of the cells, as individual cells at different points in the cultures are not necessarily in the same state of metabolic activity, and are therefore unlikely to be uniform in composition.

The chemical components determined in the tissue-culture studies have so far been confined to protein nitrogen, the acid-soluble phosphorus fraction, lipid phosphorus, ribonucleic acid phosphorus, and, of course, deoxyribonucleic acid phosphorus. As the cultures grow in plasma clot it has been necessary to modify the technique previously used by Davidson, Leslie, and Waymouth[11] to make possible the determination of nitrogen as well as the phosphorus fractions. Briefly, this involved increasing the number of cultures per roller tube to 48, reducing the film of plasma on the walls of the tubes to the very minimum required for the adhesion of the tissue, and incubating both the culture tubes and the plasma blanks, used as controls, in Tyrode-serum mixture for 24 hours at 37° C. following the period during which they were in contact with the growth-promoting medium. For the latter, we have obtained our most successful results (rapid culture growth and reduced plasma blanks) by departing from the usual procedure of preparing the medium from ice-cold and previously frozen chick embryos. Instead, guided by the demonstration of Earle *et al.*[12] that embryo extract, previously 'conditioned' by 24 hours contact with a growing culture, had a beneficial effect on culture growth from single cells, we have introduced the practice in our work of incubating the pulped embryos with Tyrode solution at 37° C. for 24 hours, before centrifuging and using the supernatant fluid (suitably diluted and with added fowl serum) as our growth-promoting agent.

The two aspects of the growth of heart explants are shown in Figs. 1 and 2. In the first the increases in the various components per forty-eight cultures are plotted against the time for which each group was in contact with the growth-promoting medium. While these increases are relatively large in all cases, it is clear that the individual components vary considerably in their behaviour during growth—in any event under our particular culture conditions. In Fig. 2 the same results are expressed in relation to deoxyribonucleic acid phosphorus, or, in other words, they are translated to show their relative amounts 'per cell' at different stages along the time-scale. The general trend here is obvious—after 48 hours there is a marked decrease in the protein nitrogen and the phosphorus fractions of the cells, with the exception of the ribonucleic acid phosphorus, which continues to increase up to 96 hours. It seems significant, too, that in this and other tests we have always found a fairly constant ratio between protein nitrogen and lipid phosphorus while their amounts per cell were changing. The close correspondence between the values of the ratio calculated from this set of cultures and from preliminary results obtained for the chick heart developing normally within the embryo from the eighth to nineteenth day of incubation is shown in Table 2. This demonstrates that there are certain quantitative similarities between the growth of explants *in vitro* and the normal growth of embryonic tissue. As will be seen later, the link between protein and phospholipid metabolism extends to other organs of the chick embryo. It is of interest here that Kosterlitz[13] found that, in livers of animals on low protein diets, loss of protein from the cells was accompanied by loss of proportional amounts of phospholipids.

Table 2. Comparison of ratios of protein nitrogen to lipid phosphorus in embryo chick heart explants growing *in vitro*, and in chick heart growing normally within the embryo

Chick heart explants		Embryonic chick heart	
Growth-period (days)	Atoms of protein nitrogen per atom lipid phosphorus	Incubation age (days)	Atoms of protein nitrogen per atom lipid phosphorus
0	39	8	28
2	36	10	32
4	36	11	26
6	41	13	32
		15	34
		17	36
		19	34

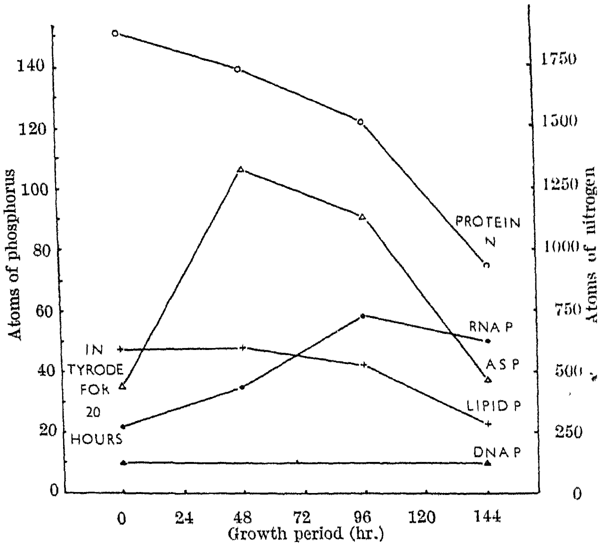

Fig. 2. Changing chemical composition of chick heart explants growing *in vitro*, as in Fig. 1. Chemical components expressed as number of atoms nitrogen or phosphorus relative to 10 atoms deoxyribonucleic acid phosphorus. *ASP*, etc., as in Fig. 1

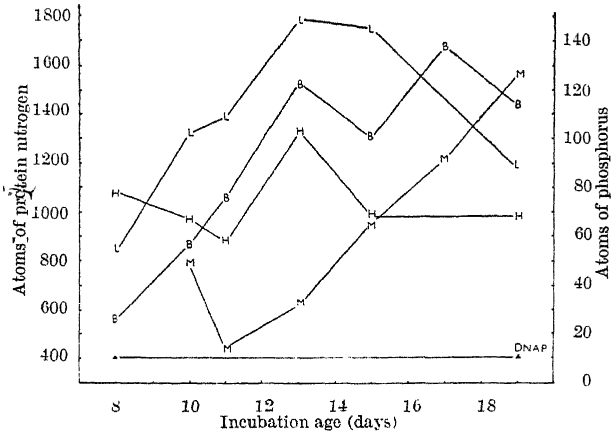

Fig. 3. Changing protein nitrogen content of embryonic chick brain (*B*), heart (*H*), liver (*L*) and muscle (*M*) relative to 10 atoms deoxyribonucleic acid phosphorus

The general pattern of chemical change, characterized by decreasing amounts of nitrogen and phosphorus fractions in the cells of the growing explants, has been found to hold for all the tests of this type. However, the quantities measured are very small, and it is likely that the absolute values of the ratios relative to deoxyribonucleic acid will require revision later as the tissue-culture techniques for biochemical studies are improved and as other methods for the determination of the nucleic acids are used in combination with phosphorus determinations. Recent tracer studies with phosphorus-32 by Davidson *et al.*[14] have revealed that associated with the ribonucleic and deoxyribonucleic acid fractions are small amounts of biologically active phosphorus which have hitherto been neglected. Although at present the accuracy of nucleic acid determinations based solely on minute amounts of phosphorus is open to question, the possible discrepancies are not so great as to invalidate the general trend of changes recorded in our cultivated explants.

We have tried to find whether the falling protein content of the cells in growing cultures is related to their reversion to a generalized cell-type by comparing it with the changes occurring in tissues which are certainly differentiating to their specific adult type. The preliminary work has been done on the brain, heart, liver and skeletal muscle (leg) of the chick embryo developing normally at 37–38° C., and the changes in the relative amounts of protein nitrogen per cell for these four tissues during the eighth to nineteenth day of incubation are shown in Fig. 3. At this stage the detailed fluctuations of the curves are not considered significant. What does clearly emerge, however, is the increasing content of protein nitrogen per cell for brain, liver and muscle over certain stages of their development—stages when the organs are growing rapidly and acquiring their functional powers prior to hatching. In contrast, there appears to be no regular increase in the protein content of the cells of the growing heart throughout the period investigated, and it may be significant that this organ has attained its final structural and functional form by the eighth day of the development of the embryo[15].

There is an apparent conflict between our finding that protein nitrogen increases per cell during periods of tissue differentiation and earlier evidence of decreasing relative amounts of protein nitrogen both in the whole chick embryo over the first four days of incubation[16], and in mammalian and avian brain tissues in their earliest stages of development[17,18]. In two of these studies the results were expressed as changes in relative concentrations and relative growth-rates, and in the case of the nervous tissue they were interpreted as showing that the tissue structure is at the start largely protein, and that the proportion of the latter decreases as lipoid and sterol molecules take their place in the nervous system[18]. It does not follow, of course, that the protein nitrogen is decreasing per cell (that is, relative to deoxyribonucleic acid) in these very early stages; but this is a possibility that can only be decided by further investigation.

Here we may perhaps speculate on the significance of these contrasting directional trends in the chemical development of growing tissue. Shall we find that differentiation of cells is accompanied by an increasing protein content of the individual cells, and that the variation in the other chemical components of the cells will follow a regular and reproducible pattern throughout the process of differentiation according to the nature of the tissues and their characteristic growth-rates? And will the process be similar but opposite in direction in the 'dedifferentiating' growth of freshly explanted tissues as our results suggest ? For, if these trends should prove to be a general feature of metazoan growth, we shall have at our disposal a method of determining the developmental ages of growing tissues and their relation to morphological and physiological changes in embryonic growth, or, in the more compact field of tissue culture, we shall be able to study the factors which influence the rate of cell growth, and alter cell characteristics.

So far we have been discussing chemical changes in growth as events occurring at intervals along the chronological time-scale. But, if we are to reveal the fundamental chemical relationships in growing tissues, we must eliminate the complicating factors which are involved in recording chemical entities as variables along an external time-scale. This can be done by making use of the simple allometric (or hetergonic) relationship $y = bx^k$ first generally applied by Huxley[19] to describe the relation of the growth of a part or organ to that of the whole organism, and, later, by Teissier[20] and Needham[21,18], to the chemical development of a wide variety of animal organisms. As Needham[18] pointed out with reference to embryonic development : "A family of curves with meaningless shapes relating a chemical entity to age for several animals may become a series of straight lines of the same slope when the entity is logarithmically plotted against the totality".

In previous studies on the simple allometry of chemical entities, the latter have had to be related on a double logarithmic grid to the totality of the organ or whole organism, as represented by its wet or dry weights[20,21,22]. While these have revealed a widespread regularity in the behaviour of many chemical entities and groups, the significance of the actual growth-ratios is not clear since the totality itself is changing in composition, and contains as one of its variables the entity under investigation. In the case of a study of face-length against total skull-length in horses, Reeve and Huxley[23] came to the conclusion "that to plot a part against another dimension which includes that part will always tend to obscure change of proportions, and should generally be avoided".

Now that we know of a constant element of the cell nucleus, these complicating factors in allometric studies can be avoided, and we can find how the

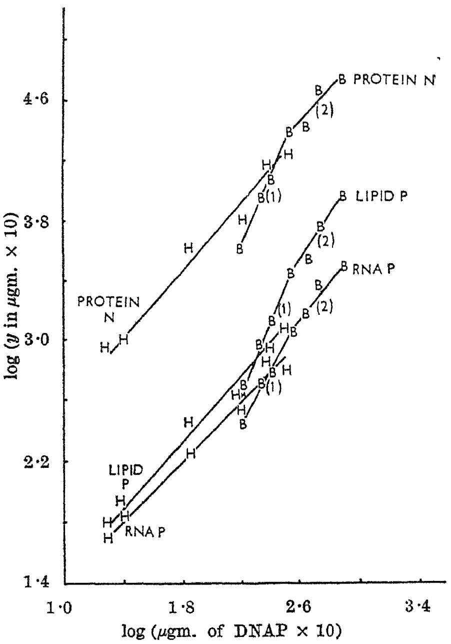

Fig. 4. Growth-ratios of protein nitrogen, lipid phosphorus and ribonucleic acid phosphorus relative to deoxyribonucleic acid phosphorus content of embryonic chick heart (*H*) and brain (*B*). Slope (k = tan α) of each line given in Table 3

growth-rates of chemical entities are related to those of a unit of the 'germ-plasm'. Needham[21] directed attention to the fact that when we plot the magnitude of chemical constituents of an organism against the magnitude of the organism as a whole, we are abstracting from morphological form, from the factors of nutrition, from the absolute values of the magnitudes, and from the time factor. By plotting instead against the deoxyribonucleic acid of the nucleus, we are carrying the abstraction a stage further, for we are, in addition, eliminating the influence of the changing chemical composition of the tissues from our results, in so far as it no longer obscures the significance of the growth-ratios. The deoxyribonucleic acid, of course, must depend on the chemical environment of the cell as a whole for its own characteristic growth-curve, and by using it as a standard of reference we reveal the changing phases of metabolic activity in developing organs and tissues. As similarities in the patterns of the relative growth-curves for different chemical entities are recognized, we shall begin to understand what Needham has called "the fundamental ground-plan of chemical growth".

Some of the first results we have obtained for the allometric relationships between various cell components and deoxyribonucleic acid phosphorus are shown in Fig. 4. Here we have plotted the logarithms of three entities of brain and heart taken from chick embryos against the logarithms of the corresponding amounts of deoxyribonucleic acid phosphorus found in the tissues. For these preliminary results the lines have been fitted to the points by eye on large-scale graphs, and their 'goodness of fit' has been tested by the graphical method of Kavanagh and Richards[24]. A striking correspondence can be seen between the growth-ratios (as represented by the slope k = tan α) of protein nitrogen, phospholipid phosphorus, and ribonucleic acid phosphorus in both organs, although the metabolic pathways in brain run quite a different course from those in the growing heart in the stages of development under comparison. In each case the growth-ratio for protein nitrogen is equal to or slightly larger than the corresponding growth-ratio for ribonucleic acid phosphorus, and this relationship also appears to hold for liver and skeletal muscle as illustrated by the values of k of the growth-ratios set out in Table 3.

Table 3. Growth-ratios (k = tan α) relative to deoxyribonucleic acid phosphorus of chemical components of embryonic chick brain, heart, liver and muscle

	Incubation period (days)	Protein nitrogen	Ribonucleic acid phosphorus	Lipid phosphorus
Brain (1)	8–13	2·55	2 10	2·45
(2)	15–19	1·05	1·00	1·30
Heart	10–19	1·05	1·00	1·05
Liver	8–19	1·1	1·0	1·1
Muscle	12–19	1·4	1·1	1·25

Results from liver and muscle suggest that a change in the course of the growth-ratios may occur at about the same stage on the deoxyribonucleic acid phosphorus scale, but to a less obvious degree than the change found in brain tissue, and consequently the values of k in the table are those for the lines which best fit all the points. When more results are available they may have to be revised.

These results make it evident that there is a definite quantitative relationship between the rate of protein synthesis and the rate of accumulation of ribonucleic acid phosphorus, and confirm the well-known views of Brachet and the Caspersson school that increasing concentrations of ribonucleic acid are associated with increased growth-rates and protein synthesis. They also show that phospholipid is in some way involved in the growth metabolism of proteins, but that it is more independent of protein nitrogen and ribonucleic acid phosphorus growth-ratios in nervous tissue, where it tends to accumulate rapidly in the cells in the later states of embryonic development. This deviation in the behaviour of brain phospholipid phosphorus becomes obvious when the latter is plotted logarithmically against protein nitrogen in chick heart, liver and brain (Fig. 5). The lines for

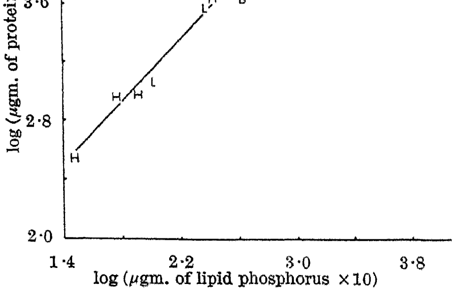

Fig. 5. Growth-ratios of protein nitrogen relative to lipid phosphorus in embryonic chick brain (*B*), heart (*H*) and liver (*L*) over incubation period 8–19 days. Growth-ratios (k = tan α) as follows: heart and liver, 1·0; brain (1), 0·95; brain (2), 0·85

heart and liver coincide (or lie very close together), whereas the points for brain are best fitted by intersecting lines which lie some distance away from the other two.

We have used these early results of our chick embryo studies to illustrate how the comparison of growth-ratios of certain chemical entities to the deoxyribonucleic acid phosphorus of the nucleus can reveal the quantitative relationships between individual entities and the changing metabolic pattern corresponding to the stages of development of the tissues. By plotting afterwards one entity against another on the double logarithmic grid, we are better able to decide whether or not they are metabolically related in the same way in all tissues. We cannot, of course, determine which is the precursor and which is the dependent entity; but a combination of the methods described above with suitable tracer techniques[25] may yet enable this to be done.

We wish to thank Mr. S. W. Morrison for helpful advice and to acknowledge that one of us (I. L.) is an Imperial Chemical Industries research fellow; and that this work was supported by a grant from the Medical Research Council.

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UNIVERSITY DEVELOPMENT IN BRITISH COLONIES

THE second report of the Inter-University Council for Higher Education in the Colonies, covering the period 1947–49*, provides a record of work of real significance for the future of the British Commonwealth. The adoption by Great Britain of a policy of trusteeship towards the Colonial dependencies carries with it the obligation to train the native populations for ultimate self-government. The attainment of this object must depend to a great extent upon an adequate supply of highly educated and well-trained local people capable of carrying the responsibilities and bearing the burdens which self-government involves. The economic development of the territories and the social services require a vast increase over the number of trained personnel at present available. Administrators, medical men, dentists, engineers, agricultural experts, teachers of all grades, technicians of all kinds are needed in ever-growing numbers. The effectiveness of the steps taken to provide them is a measure in the eyes of the native peoples of the sincerity of the efforts being made to fit them for self-government; the good-will of these peoples and so, perhaps, the ultimate retention of the territories within the Commonwealth, will depend in no small degree upon the progress made in this direction.

Outstanding among these efforts is the setting up of university institutions to serve the various territories. The report under review sets forth what has been done in this respect, and it is indeed a most remarkable record of rapid progress. Within the last two years a University, formed by the union of Raffles College and the King Edward VII College of Medicine, has come into being at Singapore; university colleges have been established in Nigeria at Ibadan, in the Gold Coast at Achimota, at Khartoum in the Sudan and near Kingston in Jamaica; and Makerere College in Uganda is expected to achieve university college status in the near future and to serve eventually as the university for East Africa. The Universities of Malta and Hong Kong are, of course, of much longer standing.

In the new institutions the establishment of proper university standards is all-important, and none is more keen in this matter than the Colonial peoples themselves. They are determined to be satisfied with nothing less than the standards of British universities. It is essential that the degrees of the eventual Colonial universities shall be recognized in Great Britain, so that no difficulties will arise in the admission of Colonial graduates to postgraduate courses in British universities. Further, the dangers of flooding the countries with large numbers of more or less unemployable sub-standard graduates is fully recognized. To safeguard the position, the university colleges have entered into 'special relationships' with the University of London, which has modified somewhat its external examination system to deal with the situation. Before admitting a college to this 'special relationship', London satisfies itself as to its autonomous character, academic control of academic policy, the suitability of the staff for teaching and research, an adequate range of subjects, proper library and laboratory facilities and suitable provision for a student corporate life. When admitted, the college staff works in close co-operation with the London authorities in matters of syllabus and examination requirements, and participates in the actual examination of its students. The degrees awarded are those of the University of London, which in this way guarantees their standard, while at the same time the disadvantages of an external degree system are minimized.

The new Colonial university institutions must inevitably be at some disadvantage at first owing to their isolation and distance from other centres of learning. To meet this problem, at least in part, the Inter-University Council has arranged for frequent visits by its members to the colleges. The Council has also representatives on the various governing bodies, the meetings of which its members attend. Members of the University of London have also paid visits in connexion with the development of the scheme of 'special relationships'. This frequent intercourse with the home universities has proved invaluable in assisting the progress of the colleges, smoothing out difficulties, promoting co-operation and removing the sense of isolation. A further important service has been rendered by the Inter-University Council by its appointment of a library advisor, whose office in London has already become an important centre of information and advice. In the preparation of book-lists, the supply of information on micro-films and other technical matters, procuring sets of periodicals, advice on buildings and furniture, on binderies and library organisation, much help is asked for and given.

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* Colonial Office. Inter-University Council for Higher Education in the Colonies. Second Report, 1947–49. (Cmd. 7801.) Pp 18. (London: H.M. Stationery Office, 1949.) 6*d.* net.

One of the most difficult and pressing problems experienced by all the new colleges is naturally that of staffing. The ultimate success of these new institutions will depend predominantly on the quality of the staff appointed, particularly in the early stages of their existence. The Inter-University Council, with the active co-operation of the home universities, has expended much effort in meeting the demand. A large measure of success has attended this work, though there are many important posts still unfilled. It is good to know that the policy of the Council is not to fill a post at all rather than to appoint an individual not up to the necessary university standard in teaching and research ability. It had been hoped to make a considerable number of appointments by secondment for limited periods up to three years of members of home universities. A few such have been made, but there is room for many more. Such appointments, it may be remarked, should benefit in the long run the seconding as much as the receiving universities.

A welcome start has been made in associating research institutes with the nascent universities in accordance with the policy of the Colonial Research Committee. Institutes of Economic and Social Research have been set up at the University College of the West Indies, at Ibadan and at Makerere College. Departments of extra-mural studies have also been established in the West Indies, the Gold Coast and Nigeria. These should have a great influence in spreading enlightenment throughout all social classes in the territories and do much to hasten their general progress.

All these developments are, of course, costing much money. The distribution by way of block grants by the Colonial University Grants Advisory Committee of £6 millions provided by the Colonial Development and Welfare Fund, the generous grants made both for current and capital expenditure by the local governments concerned, and the further direct financial support, often on a large scale, by the Colonial peoples themselves, the establishment of scholarships by local authorities and private associations, and numerous benefactions both in money and kind, all would appear to ensure a satisfactory financial future.

There can be no doubt that, though there must be difficulties and teething-troubles ahead, yet in the words of the report, "something has come alive in the Colonies in these past two years on which the hopes of many people rest". The Inter-University Council may be well satisfied by the part it has played in this highly significant development.

B. Mouat Jones

EDINBURGH CONFERENCE ON ELEMENTARY PARTICLES

THE Department of Natural Philosophy of the University of Edinburgh arranged a conference on elementary particles, to take advantage of the presence in Scotland of Prof. Niels Bohr, who has given this year's Gifford Lectures. The conference took place during November 14–16, with a full programme of lectures both experimental and theoretical. In this brief report of the proceedings it will not be possible to do justice to all of the speakers taking part.

In the experimental section of the programme, Prof. N. Feather, of Edinburgh, described various attempts to detect the presence either of negatively charged protons or of neutral particles (dineutrons) of double the mass of a neutron. It was considered that if such particles exist at all in Nature, then one might expect to find them among the radiations emitted in fission or by short-lived fission products. A typical experiment was one carried out by Fenning, at Harwell, exposing bismuth to an intense neutron flux in a pile. In this case neutron and dineutron capture will produce beta- and alpha-activity respectively, and the conditions are favourable for detecting the alpha-activity even in very small intensity. The results of this and other experiments have been entirely negative. Dr. B. Zajac and Dr. M. A. S. Ross described experimental work which is in progress at Edinburgh in the field of cosmic rays, using the photographic plate technique. They have developed an accurate and rapid method of calibration to determine the relation between grain density and specific ionization in a particular plate; they use for this purpose the tracks of electrons which come to rest in the emulsion.

Five other experimental talks were given dealing with cosmic rays: by Dr. J. G. Wilson of Manchester, Dr. B. Pontecorvo of Harwell, Dr. D. H. Perkins of Imperial College, London, Prof. LePrince Ringuet of Paris and Prof. C. F. Powell of Bristol. Dr. Perkins has studied the heavier fragments which are emitted in stars in photographic plates. The statistics are not yet good enough for trustworthy conclusions to be drawn, but it appears that a surprisingly large proportion of large fragments are emitted with relatively high velocities, the average velocity increasing with the charge of the fragment. It is difficult to understand how fragments come to be emitted with such high kinetic energies, and yet with internal excitation energies which are not great enough to cause complete disruption. Dr. Perkins suggests that the explanation may be found in the very high angular momenta which may be given to a heavy nucleus by the impact of a relativistic nucleon striking to one side of the centre of gravity. If the residual nucleus is left with a moderately large excitation energy, and with 20 or 30 units of angular momentum, then the emission of fast heavy fragments may be favoured as the most effective means of disposing of the angular momentum.

Prof. LePrince Ringuet exhibited some slides showing giant stars, in which twenty or thirty lightly ionizing tracks are seen emerging in a bundle from one side of a nuclear disintegration. Such events are *prima facie* evidence of the multiple production of mesons in a single act. However, after some discussion, it was agreed that the evidence is not conclusive, and an interpretation in terms of plural (successive) production of mesons in many individual nucleon–nucleon encounters inside the nucleus is still possible. In this connexion, Prof. L. Jánossy of Dublin presented an analysis of some experimental data obtained at Bristol, consisting of some two hundred pictures of stars with more than two lightly ionizing tracks. He showed that the experimental statistics of such tracks, including three cases of stars with more than sixteen light tracks, can be well accounted for by a hypothesis of purely plural production, using a phenomenological theory with a reasonable assumed cross-section for the production of a single meson in a single nucleon–nucleon collision. It appears that the issue of plural versus multiple production will only be decisively settled by experiments involving the production of mesons in hydrogen. In conclusion, Prof. LePrince Ringuet described an experiment to measure the masses of fast penetrating particles with a mass-spectrometer consisting of a cloud-chamber in a magnetic field combined with a suitable arrangement of absorbing plates and counters, similar to the apparatus of Alichanov, Alichanian and Weissenberg. He found no evidence for masses different from those of the well-known types of particle. He observed that protons which suffer nuclear collisions in the absorber might easily be interpreted as 'varytrons'.

Prof. C. F. Powell presented a more extensive analysis of the masses of fast particles, carried out at Bristol and based on a large number of exposures of minimum-ionization-sensitive plates at various altitudes. Two methods of mass-determination have been used, giving results which are generally in agreement. First, the small-angle scattering has been accurately measured for all tracks having a length of more than 3 mm. in the emulsion; combined with specific ionization measurements, this determines the masses of particles at non-relativistic velocities, and sets an upper limit for the masses at relativistic velocities. Secondly, Franzinetti has made observations at the Jungfraujoch with two emulsions facing each other and separated by an air-gap, the whole assembly being maintained in a magnetic field of 30,000 gauss; the deflexion of a particle in this field as it crosses the air-gap, together with its range in the emulsion, yields a measure of its mass. The results of these experiments may be summarized as follows. (i) Of all fast tracks, 98 per cent are identified as having masses corresponding to known particles. The remaining 2 per cent, which might be interpreted as τ-mesons, should probably be attributed to the effects of large-angle scattering or other instrumental errors. No new examples have been found of the peculiar types of disintegration which gave rise to the original postulation of the τ-meson. (ii) Let a 'shower particle' be defined as a particle coming out of a star and giving a track with less than one and a half times minimum ionization. Then at least 80 per cent of shower particles are π-mesons. Also, a considerable proportion of the fast ionizing particles seen entering and presumably causing stars are π-mesons. (iii) Of the fast tracks seen coming out of stars, all are either π-mesons or protons. No μ-mesons are seen, and no electrons.

Other observations reported by Prof. Powell were the following. (i) 500 examples of $\pi - \mu$ decay observed at the Jungfraujoch were analysed to see whether the μ-tracks showed any directional asymmetry, such as Wentzel has suggested might occur if the π-meson has a spin, in view of the predominantly vertical orientation of the π-producing nucleon beam. No asymmetry was detectable, a result which, of course, does not exclude the possibility of a non-zero spin for the π-meson. (ii) Many tracks have been measured of electrons with energies greater than 100 MeV., and all have grain densities less than 1·1 times minimum; thus the theoretically predicted relativistic increase of ionization with energy does not appear to exist. Dr. J. G. Wilson suggested an explanation: the relativistic increase of ionization is supposed to be due to atoms at large distances from the moving particle, in a region where ions will be formed only sparsely and with small energies; thus if the photographic grains respond not to single ions but to groups of ions close together, the extra ionization produced by a highly relativistic particle will not produce a corresponding increase in grain density. (iii) Using an analysis of small-angle scattering, King at Bristol has measured the energies of electron–positron pairs which are generated in plates at high altitudes by photons of the soft component; in a large stack of plates, the frequency of such pairs increases with depth in the stack, so that a considerable proportion of the originating photons are locally generated, and it may be presumed that these photons arise in part from nuclear collisions in the upper layers of the stack. The observed energy distribution of the pairs has a maximum at about 100 MeV., falls off rather steeply below this maximum and more gradually above it. Such a distribution is pleasantly suggestive of a neutral meson of mass 300, which is created in nuclear collisions and decays at once into two photons. However, these observations are still at a preliminary stage. (iv) Numerous examples have been found of the so-called 'giraffe' events (nomenclature due to Occhialini) in which one relativistic track suddenly splits into three relativistic tracks with very small angular divergence. From scattering measurements, it is found that there is a rough energy-balance between the one ingoing and the three outgoing tracks; also the rest-masses of all particles involved are of the order of the electron mass. The frequency of these events seems much too great for them to be explained as pair-creations due to an electron passing through the field of an atom. They remain a mystery, about which it is hoped more will be heard.

In the theoretical section of the programme there were three talks describing the work of the Edinburgh school, one by Prof. Max Born himself, one by Dr. L. M. Yang and one by Dr. Kai-Chia Cheng. These talks gave a general account of the reciprocity theory of elementary particles which Prof. Born has originated. The theory aims at providing, at one blow, a consistent formalism free of divergences for the description of quantized fields, and an explanation of the various types of existing particles and their masses. Since the theory is yet by no means in a complete form, the conference was not in a position to pass judgment upon it. Because of its technical mathematical character, no attempt will be made to summarize it here.

Prof. Niels Bohr gave a talk on the theory of elementary particles, in which he described the ideas and methods which were followed in the analysis of the concepts of quantum electrodynamics which he has recently completed with Prof. L. Rosenfeld. The result of this analysis has been to show that the concepts of quantum electrodynamics form a logically consistent and intelligible framework. This makes the future task of the theoretical physicist more difficult rather than easier, because it is now clear that the real problems concerning the nature and existence of elementary particles cannot be met and attacked within the domain of electrodynamics.

Other theoretical papers were read by Prof. F. Bopp of Munich, Prof. L. Jánossy of Dublin, Prof. M. Fierz of Basle, and by Sir Charles Darwin. Prof. Bopp presented a new method for formulating the dynamics of particles interacting with an electromagnetic field, when the Lagrangian of the system involves not only particle velocities but also accelerations; he is able to quantize this formalism, and to obtain from it various elegant consequences; however, the quantized theory is not yet completely worked out and adapted for practical use.

At the end of the theoretical programme, Sir Charles Darwin put forward some radical speculations concerning the origin of cosmic rays, which aroused widespread discussion. He first proposed for consideration the phenomenon of pitting of marine propeller-blades as a result of cavitation at the surface of the blades; in this phenomenon a small hemispherical cavity in the water is supposed to collapse in a symmetrical manner, and it follows from the laws of hydrodynamics that a very small mass of water in contact with the blade will arrive at the centre of the cavity at the instant of collapse with an immensely high velocity. He suggested that the origin of cosmic rays be sought, not in any thermodynamically stable process, but in some violently non-thermodynamical and co-operative phenomenon such as he had described. Pushing a little farther the analogy with cavitation, he proposed for investigation the possibility that cosmic rays could be generated in the collapse of large vacuous regions formed by the turbulent motions in stellar atmospheres [see also *Nature*, December 31, p. 1112]. Sir George Thomson, however, pointed out that because of the well-known order of magnitude of the cosmic-ray flux, either the generation process in stars must be unreasonably efficient, or else the generation must be taking place in our own sun.

Present at the conference were about a hundred physicists, representatives of ten countries. Russian physicists, who also had been invited to attend, were absent. However, at one of the sessions Prof. Born read a telegram which he had received from Prof. Vavilov, president of the Academy of Sciences of the U.S.S.R., apologizing for not sending a delegate and expressing friendly interest in the proceedings of the conference.

OBITUARIES

Prof. D. R. Hoagland

The death of Dennis Robert Hoagland, professor of plant nutrition in the University of California, Berkeley, has removed an illustrious plant physiologist and one of the world's leading authorities in the broad field of plant and soil interrelations. For more than thirty years he laboured with distinction and devotion toward the understanding of the extremely complex plant–soil–atmosphere system as it exists in Nature.

Hoagland was born in Golden, Colorado, and received his early education in Denver. In 1903 he went to study chemistry at Stanford University. Following a distinguished undergraduate career he first elected to go on with advanced work in chemistry; but in 1908 he accepted a position in the Laboratory of Animal Nutrition in the University of California. The new position brought him for the first time in professional contact with biology and took him to Berkeley, where, except for a few short gaps, he was to spend the rest of his life.

Hoagland remained in the field of animal nutrition for five years, the last of which he spent in research under Prof. E. V. McCollum, of the University of Wisconsin. In later years, Hoagland looked back on his association with Prof. McCollum as his real inspiration for a life devoted to scientific research. There would normally have been every expectation that he would continue in this field, but circumstances intervened and the acceptance in 1913 of a position as assistant professor of agricultural chemistry brought him back to Berkeley and was the initiation of his work in plant nutrition.

One of his early research activities concerned itself with the effect of hydrogen-ion concentration on plant growth. It was with great surprise that he discovered that, contrary to the then accepted tenets of agricultural teaching, barley plants made excellent growth at *p*H 5. It was apparent that the inherent complexity of soils rendered untrustworthy many sweeping generalizations based on local conditions. He became convinced that the complex problem of soil and plant interrelations could best be studied by techniques which permitted rigid experimental control and the isolation of individual variables. He afterwards developed to a very high degree the water-culture technique for growing plants which has since, for more than three decades, served as a powerful and discriminating tool for studying fundamental problems in plant physiology at Berkeley. In later years he was also instrumental in securing one of the first experimental chambers in the United States for the growing of plants under reproducible conditions of light, temperature and humidity.

His early and dominant research interest was in the process of absorption and accumulation of ions by plants. The quality of the immense contribution which he, with his collaborators and associates, made to this fundamental process of plant physiology can only be judged against a background of the ideas and concepts which prevailed when his work got under way. There was no clear view as to how inorganic elements are absorbed by plants. Discussions of this subject were usually invoking such concepts as osmosis, permeability, antagonism, none of which, as he later clearly demonstrated, could explain their absorption, accumulation and retention against a concentration gradient of anions and cations by plant cells.

Hoagland first became interested in the special nature of ion absorption by plants during the First World War, when during a search for domestic sources of potassium, he discovered the remarkable ability of the giant kelps of the Pacific Coast to accumulate potassium and iodine many times in excess of the concentrations found in the sea. He returned to this problem several years later, using first intact barley plants and, later, a unicellular fresh-water alga, *Nitella*. This work clearly demonstrated that absorption of ions by plants is a metabolic process requiring energy and not a question of simple permeability. His work with *Nitella* allowed him to paint in bold strokes a theory which at once correlated a host of observations in the field and laboratory and made it possible to approach an infinitely complex subject with principles instead of mere empirical observations. The next phase of his researches on ion accumulation brought him closer to the system which was uppermost in his mind—the absorption of nutrients by the roots of higher plants. Using excised barley roots of known and reproducible physiological status, an impressive array of results was amassed on the influence of light, temperature, *p*H, ion selectivity, concentration of ions in the external medium, differences in rates of absorption and the effect of one ion on the absorption of another. A striking correlation was obtained between the supply of oxygen and the absorption of salts by roots against a concentration gradient. A solid scientific foundation was thus laid for the understanding of the importance of aeration in soils and for the interpretation and prediction of a multiplicity of plant responses to fertilization treatments and other chemical changes in the soil. The final phase of his investigations on absorption of ions occurred just before and during the Second World War, when many of his earlier conclusions were confirmed and extended with the use of the sensitive technique of radioactive isotopes.

Dominant as his life-long interest in the process of ion absorption was, it by no means prevented him from pursuing with vigour other phases of plant nutrition to which he, with his associates, made outstanding contributions. He studied by means of different techniques, including some of the earliest application of radioisotopes, the upward movement and distribution of inorganic solutes in the plant. He was keenly interested in problems of soil chemistry in so far as they affect the nutrition of crops grown in the field. His own work was especially concerned with zinc, potassium and phosphate deficiencies of fruit trees in California. He contributed to the identification of one of the most important physiological diseases of fruit trees in California, 'little leaf', with zinc deficiency, and reproduced it under controlled greenhouse conditions. His investigations of potassium nutrition had a bearing on 'prune dieback', another nutritional disease of fruit trees in California, and led to extended studies of the chemical aspects of potassium availability in soils. His interest in the nutrition of fruit trees continued, and in 1940 he produced, under controlled conditions, the first molybdenum-deficiency symptoms in a fruit tree species.

Hoagland's entire life as a productive scientific worker was spent in association with agricultural research. He had a profound faith in the importance to agriculture of fundamental research, without thought and expectation of immediate practical returns. He was fully aware of the often wide gap between laboratory result, obtained under controlled conditions, and the field application, complicated as it is by a multiplicity of factors. He was conscious not only of the promise but also of the limitations of science in agriculture. In dealing with living plants and animals he was mindful that "it still takes the wheat plant six or nine months to develop and cows bring forth their calves neither more quickly nor more numerously for us than they did for Abraham". He believed that the contribution of science to agriculture must be judged not only by its material achievements but also by the enlightenment it proffered to the farmer and city dweller alike about the intricacies of plants and soils. Though a chemist by training, he acquired early the outlook of a biologist and was mindful of the inherent complexity of biological systems, their adaptive properties to varying conditions, and hence he distrusted the spectacular short-cut or facile generalization unless it was supported by solid experimental evidence.

Hoagland's chief characteristic, whether in scientific matters or personal relationships, was integrity and objectivity of outlook. In evaluating scientific evidence he had the "four things" which Socrates said "belong to a judge: to hear courteously, to answer wisely, to consider soberly, and to decide impartially". He applied the same critical standards to his own work as to that of others. He accepted no blanket authority in science, and expected every single piece of research to stand on its own merits regardless of its source. In personal relationships he possessed the engaging quality of always seeking the good in men and their work. In approaching students, he had a rare gift of making them sense the good-will and confidence in their ability with which he always credited them at the start. His students were spurred to special efforts by a desire to prove themselves worthy of his trust. Hoagland's confidence and friendship once given were not easily withdrawn. Never demonstrative in manner, he had a deep loyalty and an unfailing concern for the welfare of his friends and associates.

Hoagland was the not altogether common scientist who carried the scientific mode of thinking outside his own speciality into diverse areas of human thought and achievement. He maintained an active interest not only in many departments of science but also in fundamental questions of education and in the social and political problems of the contemporary scene. It was a stimulating experience to witness his well-stocked mind analyse a complex issue with clarity and insight which unerringly penetrated to the root of the matter. Whatever the subject may be, his discussions had a special flavour of emotional and intellectual maturity which excluded bias and preconceived notion. In the seventeen years during which I was associated with him as a student, colleague and friend, I never once heard him discuss a person or an issue, scientific or otherwise, except in a fair and objective manner.

It is only natural that his accomplishments, his qualities of mind and character gained him wide recognition and many honours. His counsel was sought and valued within his own University, to which he gave unstintingly of time and effort in many arduous administrative assignments, usually at the expense of his own leisure and in later years at the expense of his health. In 1934 he was elected a member of the National Academy of Sciences. The American Society of Plant Physiologists, which was his closest scientific affiliation, bestowed upon him its highest honour by granting him, in 1929, the first Stephen Hales award in recognition of his outstanding research contributions. He was also elected president of the Society and occupied other important offices in it.

The high esteem in which he was held by plant physiologists throughout the world is attested by his recent appointment as president of the Section of Plant Physiology at the forthcoming Seventh International Botanical Congress to be held in Sweden in 1950. Unfortunately, poor health forced him to decline this international honour.

Many other societies in which he held membership honoured him in various ways. In 1940 the American Association for the Advancement of Science awarded him the 1,000 dollars prize for an outstanding paper presented at the Philadelphia meetings. In 1942 he was invited by Harvard University to give the John

M. Prather lectures. The lectures were later published in book form, and constitute the only book which he found leisure to prepare.

His own colleagues in the various faculties bestowed upon him the highest honour within the University, by appointing him faculty research lecturer in 1942.

Hoagland was never in robust health; but a strong sense of duty compelled him to carry on without a thought for his own personal well-being. The last four years of his life were marred by serious illness. He carried on with courage and determination to within the last few months of his life, when his eyesight failed him almost completely. This latter blow was the severest of all, for throughout his life he enjoyed reading on a wide variety of subjects. It was characteristic of the man that once he gave up hope of regaining his health he requested retirement from the University, ignoring the serious financial adjustment that such a voluntary step would involve. He was officially retired on July 1, 1949, and died almost two months later.

In 1920 he married Jessie A. Smiley. She died suddenly of pneumonia in 1933. He was left with the responsibility of bringing up three young boys. His three sons, his mother and a brother survive him.

The scientific influence of Prof. Hoagland's life has not come to an end with his death, but will continue through the deep impression which he made on the minds and hearts of his students and friends.

DANIEL I. ARNON

WE regret to announce the following deaths:

Mr. Joseph Bailey, formerly of the Ministry of Education, sometime president of the Museums Association, on January 4, aged eighty-nine.

Dr. Isaiah Bowman, president since 1935 of Johns Hopkins University, on January 6, aged seventy-one.

Prof. Stefan Meyer, one of the pioneer workers in radioactivity and for many years director of the Vienna Radium Institute, on December 29, aged seventy-seven.

NEWS and VIEWS

Wool Industries Research Association:
Dr. A. B. D. Cassie

THE announcement that Dr. A. B. D. Cassie has been appointed director of research of the Wool Industries Research Association will be received with satisfaction by his many friends in academic and industrial life. A graduate in mathematics and physics of the Universities of Edinburgh and Cambridge, he first carried out research in Prof. F. G. Donnan's laboratory at University College, London. In conjunction with C. R. Bailey, he published some twenty papers on the infra-red spectra and structure of triatomic molecules, and then in 1934 joined the staff of the Dyestuffs Division of Imperial Chemical Industries. During the following two years, he introduced dielectric and power-loss methods of indicating the state of aggregation of fillers in rubber, and then transferred to the Royal Aircraft Establishment, where he worked with Sir Ben Lockspeiser until his appointment as chief physicist at the Wool Industries Research Association in 1938. Since that time his special interest has been the adsorption of water vapour by textile fibres. After studying the simultaneous propagation of heat and water vapour through hygroscopic textiles, which provided a clear indication of the physical properties associated with the warmth of clothing, he made an important contribution to the theory of water adsorption by textile fibres by giving the first statistical derivation of Brunauer, Emmett and Teller's adsorption isotherm. More recently, he has devoted his energies to water-repellency, and his elegant work in this field, by directing attention to the importance of surface structure, has served to explain several unusual phenomena associated with plant and animal surfaces. For these and other investigations he was awarded in 1946 the Warner Memorial Medal for investigations in textile technology. Dr. Cassie succeeds Mr. B. H. Wilsdon as director of research during a period of expansion of the buildings and equipment of the Research Association, and their previous close association will ensure continuity of development during a critical phase in the history of the wool textile industry.

Research on Cortisone and Related Substances at Oxford

IN *Nature* of December 31, p. 1117, it was announced that the Nuffield Foundation had made a grant to the University of Cambridge for research on adrenocorticotropin in pursuance of the special interest it has shown in work bearing on the causes and cure of rheumatism. A parallel grant, of £10,000, has also been made to the University of Oxford for a study of the synthesis of cortisone and its analogues in the Dyson Perrins Laboratory under the supervision of Sir Robert Robinson. Although it is probable, as Sir Robert has himself stated in his presidential address to the Royal Society (*Nature*, December 17, p. 1025), that synthesis of Li's peptide hydrolysate of adrenocorticotropic hormone offers the better approach, the attack on cortisone itself must also be made. The problem is one of great difficulty, and the preparation of cortisone has hitherto been effected only from material of natural origin, such as the desoxycholic acid of bile. This is hopeless for large-scale working and is said to require no less than thirty-five stages. Synthesis from a plant sapogenin, namely, sarmentogenin, about halves the number of stages, but this also is an unattractive proposition. The complete synthesis seems a more or less hopeless quest, but it is hoped at Oxford to make two kinds of substitutes. The first would be a near analogue such as might result from work among molecules rather closely related to cortisone. The second would be an analogue in which the cortisone structure is simulated in a much simpler structure. In other words, one objective of research is to find the substance that will bear the relation to cortisone that stilbœstrol bears to œstradiol. The feasibility of this cannot be assessed at this time, because we do not know how narrowly specific may be the constitutional–physiological relationship.

Tsetse Control in the Gold Coast

DR. KENNETH MORRIS has been appointed director of the newly established Tsetse Control Department, Gold Coast; this Department has arisen out of the trypanosomiasis campaign, which was an offshoot of the Medical Department. In view of the ramifications of the tsetse problem, touching on the activities of many departments, including those of agriculture and veterinary and medical work, it was felt that it must now be attacked on the broadest lines by proper land planning and land utilization in order to achieve permanent results. Sleeping sickness has now been brought under control in the Gold Coast, and this success requires consolidation by settlement and mixed farming, with consequent attention to trypanosomiasis of domestic animals. Large-scale research and experiment on the control of *Glossina morsitans* in particular are in progress, together with the epidemiological studies necessary for the planning of control operations. An article on tsetse control (by Dr. Morris) was published in *Nature* of December 31, p. 1114.

Imperial College of Tropical Agriculture, Trinidad : *Newsletter*

The Imperial College of Tropical Agriculture, St. Augustine, Trinidad, issued in October 1949 the first number of a *Newsletter*, a modest publication of three sheets, the object of which is to impart frequent up-to-date information about current College happenings and affairs. The publication is circulated to appropriate government departments, other official bodies and commercial concerns and to the local press and other public information services. The first part is devoted to staff changes and appointments. The next section deals with student notes, from which it is learned that there are fifty-six students now in residence, of which thirty-six are undergraduates studying for the diploma of the College, and twenty are postgraduates entered for the associateship of the College or the diploma in tropical agriculture (Trinidad) or attending special courses. The bulk of the students come from the British West Indies, but some are from other parts of the British Commonwealth, and there is one each from Brazil, the Dominican Republic, Surinam and the United States. In the notes on activities of the staff it is noteworthy that the Principal recently travelled in West Africa to discuss there with educational authorities the arrangements for African students to take courses at the College.

Four new staff houses were scheduled for completion by the end of 1949, and the construction of the new biology building is in progress. Reference is made to the reports of the Governing Body and of the Principal, which deal in particular with progress made in the four research schemes (banana, cocoa, soils and sugar) and with the development of the new College farm. It is stated that, owing to difficulties of production, only two six-monthly omnibus numbers of *Tropical Agriculture* appeared in 1949; it is hoped to resume monthly publication this year. Among the staff the following appointments have been made: Mr. P. Holliday (Cambridge), pathologist in cocoa diseases; Miss M. E. M. Price (Toronto), librarian; Mr. E. G. D. Pritchett (Oxford and Toronto), farm manager. The second issue notes the appointment of Sir Raymond Priestley in succession to the late Sir Frank Stockdale as chairman of the Governing Body, and the resignation of Prof. A. de K. Frampton, professor of agriculture, on his appointment as agricultural adviser to the Development and Welfare Organisation in the West Indies. The London office of the College is at 40 Norfolk Street, London, W.C.2.

Nationalized Audit Service

At one of its recent sectional meetings the British Institute of Management discussed the need for an independent management audit service for nationalized undertakings, though no final recommendations were agreed by the meeting (B.I.M. Conference Series 11. Pp. 36. London: 17 Hill Street, W.1, 1949. 2*s*. 6*d*.). Mr. F. C. Hooper, in introducing the subject, explained that in essence a management audit is a fault-finding body, since its main job is to find out what is wrong and to set in motion steps to put it right. It cannot, however, be usefully conducted on a nationalized undertaking by an outside group of people; but there should be at least one member of the audit drawn from outside the undertaking who should be of the highest professional and public standing. The remaining members, including the chairman, should be drawn from within the undertaking. The chairman and at least one other member should be top-level executives or members of the board, whichever is appropriate. Mr. Hooper also suggested that it would be a good thing to include workers' representatives, especially in regional audits.

International Conference at Florence of University Teachers

The fifth conference of university teachers organised by the International Association of University Professors and Lecturers will be held at the University of Florence during April 12–16, under the chairmanship of Prof. A. Portman, of the University of Basle. The conference will be open to all members of the Association and others interested, and university institutions are invited to send representatives. Definitive reports on the following three topics will be considered: (1) equivalences of university qualifications; (2) arrangements in the universities for periodical long leave; (3) student health services in universities. Progress towards the establishment of an International Institute of the Social Sciences will be reported. The present position of the Association will be reviewed and suggestions considered regarding its immediate future programme. Social gatherings will be arranged, and there will be opportunities of seeing other centres of science and learning, such as a visit to the University of Siena on April 15. Names of those expecting to attend the conference should reach the Secretary at as early a date as possible; the registration fee is 10*s*. Further particulars can be obtained from Mrs. Cecil, Secretary, I.A.U.P.L., 13 Old Square, Lincoln's Inn, London, W.C.2.

Exhibition in London of French Scientific Instruments

An exhibition of scientific instruments, similar to the annual one held in Paris by the Société Française de Physique (see *Nature* of December 24, 1949, p. 1077), is shortly to be held at the Science Museum, South Kensington, London, S.W.7. The aim of the exhibition, which was conceived in French scientific circles, will be to demonstrate to the British scientific public the present state of instrument technology in France. The exhibits will represent the work of the Centre National de la Recherche Scientifique, the Office National d'Etudes et de Recherches Aeronautiques, the Commissariat à l'Energie Atomique and a number of scientific instrument manufacturers. While the emphasis will be on instruments for physical research, other branches of study will be represented, including photography, medical physics, civil and mechanical engineering and chemistry. The exhibition is under the patronage of the Cultural and Commercial Counsellors to the French Embassy. During the course of the exhibition a number of public lectures by French men of science will be given, details of which will be announced shortly. The exhibition will be open to the public without charge during February 9–26 (weekdays, 10 a.m.–6 p.m.; Sundays, 2.30–6 p.m.). A comprehensive catalogue of some 100 pages will be on sale at the Museum, and representatives of the participating bodies will be present throughout to assist visitors with additional technical information.

Physical Society's Annual Exhibition

The thirty-fourth annual Exhibition of Scientific Instruments and Apparatus arranged by the Physical Society will be held during March 31–April 5 inclusive at the Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7. The Exhibition will be open on March 31, April 3 and April 4 from 10 a.m. to 1 p.m. and from 2 p.m. to 9 p.m., and on April 1 and April 5 from 10 a.m. to 1 p.m. and from 2 p.m. to 5 p.m. The morning session on March 31 is for fellows of the Society and the Press only. It will be noted that the Exhibition is to remain open for a longer period than in previous years. Invitations to exhibit have been accepted by firms, research associations, universities and government departments as in the past, and the handbook of the Exhibition containing descriptions of all items to be displayed will be available from the Secretary-Editor, Physical Society, 1 Lowther Gardens, Prince Consort Road, London, S.W.7, at the beginning of March, price 6*s*. post paid. During the Exhibition, discourses will be given by Prof. S. Chapman, Dr. W. D. Wright, Dr. F. J. Scrase and Sir Robert Watson-Watt. The Craftsmanship and Draughtsmanship Competition for Apprentices and Learners is again being held, and some of the entries will be on view at the Exhibition.

Zoological Society of India: 1949 Elections

Foundation fellows of the Zoological Society of India, who were elected in 1949, are as follows: Dewan Anand Kumar (Solan), Dr. A. A. Ayer (Madras), Dr. K. N. Bahl (Lucknow), Dr. D. V. Bal (Bombay), Dr. J. L. Bhaduri (Calcutta), Dr. D. R. Bhattacharya (Allahabad), Dr. B. S. Bhimachar (Calicut), Dr. B. S. Chanhan (Calcutta), Dr. B. N. Chopra (New Delhi), Dr. B. K. Das (Hyderabad), Mr. M. N. Datta (Calcutta), Prof. R. Gopala Aiyer (Waltair), Dr. S. L. Hora (Calcutta), Dr. M. O. T. Iyengar (Calcutta), Dr. T. S. Job (Barrackpore), Dr. G. L. Kestiven (Singapore), Dr. K. B. Lal (Kaupur), Dr. M. S. Mani (Agra), Prof. H. R. Mehra (Allahabad), Prof. M. B. Mirza (Aligarh), Prof. A. B. Misra (Benares), Dr. K. S. Misra (Calcutta), Prof. M. A. Moghe (Nagpur), Dr. K. B. Nair (Trivandrum), Dr. N. K. Panikkar (Mandapani), Dr. H. S. Pruthi (New Delhi), Dr. L. S. Ramaswami (Bangalore), Dr. H. S. Rao (Mandapani), Dr. H. N. Ray (Mukteswar), Dr. M. L. Roonwall (Dehra Dun), Prof. B. R. Seshachar (Bangalore), Prof. R. V. Seshaiya (Annamalainagar), Dr. S. B. Setna (Bombay), Lieut.-Colonel R. B. Seymour Sewell (Cambridge), Miss N. G. Sproston (Shanghai), Dr. B. Sundara Raj (Lucknow), Dr. Viswanath (Hoshiarpur), Dr. G. S. Thapar (Lucknow), and Dr. A. Wolsky (Delhi).

University of Adelaide

An announcement has been made inviting applications for twenty-eight new teaching posts, including chairs of philosophy, mathematics and physics, at the University of Adelaide. The size and resources of this University, which has always played a leading part in Australian science and thought and has produced an unusual number of persons now outstanding in British scholarship, have already expanded considerably since the end of the War. The further development which is now projected is the result of the decision of the Government of South Australia to make a substantial increase in its University vote, following representations by the vice-chancellor, Mr. A. P. Rowe, who was appointed in 1947. It is intended that the new appointments (for which applications close in London with the Association of Universities of the British Commonwealth on January 31) should make possible not only the extension into new fields of the University's teaching and research activities, but also a liberal provision of overseas study-leave for all members of the staff and a reversion to pre-war conditions in the matter of reasonable freedom from teaching duties for research.

University of London: Appointments

The following appointments in the University of London have been announced: Dr. E. H. F. Baldwin, to the University chair of biochemistry tenable at University College from January 1; Prof. H. E. M. Barlow, professor of electrical engineering at University College, to the Pender chair of electrical engineering tenable at the College from October 1, 1950, in succession to Prof. R. O. Kapp, who will be retiring at the end of the session 1949–50. The title of professor of chemistry in the University has been conferred on Dr. Kathleen Lonsdale in respect of the post held by her at University College; and the title of professor of aeronautical engineering in the University on Dr. N. A. V. Piercy, in respect of the post held by him at Queen Mary College.

Announcements

The University of Leeds has recently received an anonymous gift of £40,000 towards the cost of the rayon technology building, and also the following grants: £5,000 to Prof. W. T. Astbury from the Nuffield Foundation for fundamental investigations on rheumatoid arthritis; £2,000, spread over two years, to the Department of Biomolecular Structure from the International Wool Secretariat; and £1,432 from the Royal Society for research in the Physics Department.

In the article on "Acoustics of Rooms" in *Nature* of December 24, p. 1080, reference is made to various bodies having contributed towards the cost of Dr. R. H. Bolt's visit to Britain to give the lectures which the article describes. Mr. Joseph Emberton, chartered architect, points out that he is not connected with Electrical Musical Instruments, Ltd., and made a gift purely on his own account.

Further details in connexion with the second Oil Shale and Cannel Coal Conference of the Institute of Petroleum have recently been announced (see *Nature*, August 6, 1949, p. 216). The dates of the Conference are July 4–6, and it will take place at the Royal Technical College, Glasgow. The Conference will open with the James Young Centenary Lecture, and this will be given by Prof. W. M. Cumming. Further details can be obtained from the Secretary of the Institute of Petroleum, 26 Portland Place, London, W.1.

THE PYKNO-X-RAY METHOD FOR DETERMINING ATOMIC MASSES

By Prof. T. BATUECAS

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IN view of the precision reached in the determination of crystal densities and X-ray data for solids, it is now possible to determine atomic masses with accuracy. This new method, which C. A. Hutchison and H. L. Johnston[1] applied for the first time to lithium fluoride, to deduce the atomic mass of fluorine, is based on the comparison of the solid to be studied with calcite, of which the density, grating space and geometrical structural constant are all known with great precision. Recently I suggested[2] that calcite may not be the best reference substance, and that perhaps it would be better to take for this purpose sodium chloride. But whatever substance is selected as standard, it is desirable that the densities and X-ray data, both of the substance chosen and the standard, should be compared at the same temperature. Unless this is done, corrections involving coefficients of thermal expansion are necessary which involve uncertainties of varying importance in the results. However, in my opinion these uncertainties can be reduced to a minimum and even cancelled out by simplifying the method in the way described below.

Nevertheless, before explaining with concrete examples how the atomic masses are worked out by means of the new pykno-X-ray method, I think it necessary to point out that the Avogadro number N_A adopted is not the value calculated by R. T. Birge as the most probable value, namely, $N_A = (6{\cdot}0233_8 \pm 0{\cdot}0004_3) \times 10^{23}$ mol.$^{-1}$, but $N_A = (6{\cdot}0231 \pm 0{\cdot}0004) \times 10^{23}$ mol.$^{-1}$ (rounded off to three places of decimals), deduced by the same author[3] from very accurate measurements at 20° C., carried out with several samples of calcite in which the slight impurities were taken into account. Obviously the value we adopt for N_A corresponds to only one substance, calcite, whereas the more probable value represents the weighted mean of five independent values; but as in the pykno-X-ray method it is necessary to have a reference substance, and as this obviously cannot be oxygen, calcite is the best choice for the Avogadro number.

In support of this view I give below an account of the results deduced for the atomic masses of carbon, sodium, potassium, fluorine, silicon, arsenic and lead, taking the values that in my opinion must be considered as the best ones for diamond, sodium chloride, potassium chloride, lithium fluoride, silica (SiO_2), arsenic trioxide (As_4O_6) and galena (PbS). The calculations have been carried out taking into account that the molecular mass of a crystal depends on: (*a*) the volume of its unit cell; (*b*) the number of molecules contained in the latter; (*c*) its density (ρ); and (*d*) the Avogadro number N_A. Since these values are known—at a given temperature—for each substance, a simple formula enables the atomic mass to be calculated. Finally, in the formulæ I propose, the crystal density and the grating space must be expressed in the absolute system.

Diamond. With the density at 23·5° C. determined by J. A. Bearden[4], using the 'free submerged float' method, $\rho^{23\cdot5} = (3{\cdot}51536 \pm 0{\cdot}00004)$ gm./cm.^{3}, and the coefficient of cubic expansion, $\alpha = 3{\cdot}54 \times 10^{-6}$, we deduce: $\rho^{20} = 3{\cdot}51540$ gm./cm.^{3}. For the grating space we take the value given by Y. Tu[5]: $d^{20} = 3{\cdot}55966$ A., or $d'^{20} = 3{\cdot}56688 \times 10^{-8}$ cm., because in multiplying by 1·00203 we transform to absolute the values based on Siegbahn's scale. As in the diamond the unit cell contains eight atoms of carbon, the formulæ to be employed are: $8 M_{\text{diam.}} = N_A \cdot \rho_{\text{diam.}} \cdot d'^3_{\text{diam.}}$, and substituting values I deduce for the atomic mass of carbon,

$$C = 12{\cdot}010_8.$$

Sodium chloride. Using the 'temperature of flotation' method, H. L. Johnston and C. A. Hutchison[6] found for the density at 27·634° C. of very pure sodium chloride: $\rho^{27\cdot634} = (2{\cdot}16165 \pm 0{\cdot}00002)$ gm./ml. As the coefficient of thermal expansion is: $\alpha = 1{\cdot}21 \times 10^{-4}$, I deduce: $\rho^{18} = 2{\cdot}16418$ gm./ml., or $\rho^{18} = 2{\cdot}16412$ gm./cm.^{3}. Taking as grating space the value given by Y. Tu[5]: $d^{18} = 5{\cdot}62836$ A., or $d'^{18} = 5{\cdot}63978 \times 10^{-8}$ cm., the formula $4.M_{\text{NaCl}} = N_A \cdot \rho_{\text{NaCl}} \cdot d'^3_{\text{NaCl}}$ gives: $M_{\text{NaCl}} = 58{\cdot}456$. Finally, adopting Cl = 35·457, we deduce for the atomic mass of sodium,

$$Na = 22{\cdot}999.$$

Potassium chloride. By the 'crystal suspension' method, C. A. Hutchison[7] gave for the density at 28·098° C. of very pure potassium chloride: $\rho^{28\cdot098} = (1{\cdot}98651 \pm 0{\cdot}00002)$ gm./ml. Using as coefficient of thermal expansion[8] the value: $\alpha = 1{\cdot}13 \times 10^{-4}$, we have $\rho^{18} = 1{\cdot}98877$ gm./ml. or $\rho^{18} = 1{\cdot}98872$ gm./cm.^{3}. Taking for grating space the value[9] $d^{18} = 6{\cdot}27816$ A. or $d'^{18} = 6{\cdot}29090 \times 10^{-8}$ cm., and substituting these values in the formula $4.M_{\text{KCl}} = N_A \cdot \rho_{\text{KCl}} \cdot d'^3_{\text{KCl}}$ we have: $M_{\text{KCl}} = 74{\cdot}554$, and subtracting Cl = 35·457, we deduce for the atomic mass of potassium,

$$K = 39{\cdot}097.$$

Lithium fluoride. Taking for density at 27·67° C. the value given by C. A. Hutchison and H. L. Johnston[1]: $\rho^{27\cdot67} = (2{\cdot}63835 \pm 0{\cdot}0001)$ gm./ml., and as coefficient of thermal expansion[10] $\alpha = 1{\cdot}00 \times 10^{-4}$, the density of lithium fluoride at 20° C. will be $\rho^{20} = 2{\cdot}64037$ gm./ml., or $\rho^{20} = 2{\cdot}64030$ gm./cm.^{3}. For the grating space of lithium fluoride, Straumanis, Ievins and Karlsons[11] gave $d^{20} = 4{\cdot}01739$ A. or $d'^{20} = 4{\cdot}02555 \times 10^{-8}$ cm. Using the formula $4M_{\text{LiF}} = N_A \cdot \rho_{\text{LiF}} \cdot d'^3_{\text{LiF}}$, and substituting the various numerical values, we have: $M_{\text{LiF}} = 25{\cdot}935_2$; finally subtracting Li = $6{\cdot}939_0$, we find for the atomic mass of fluorine,

$$F = 18{\cdot}996.$$

Silica (*α-quartz*). The pyknometric measurements at 0° C. carried out by C. Gutierrez Losa in this Laboratory, using my precision technique[12] with very pure transparent quartz, give for the density of SiO_2, $\rho^0 = (2{\cdot}6508 \pm 0{\cdot}00008)$ gm./ml., or $\rho^0 = 2{\cdot}6507_4$ gm./cm.^{3}. Taking as coefficient of cubic expansion the value $\alpha = 3{\cdot}529 \times 10^{-5}$, the density at 18° C. will be $\rho^{18} = 2{\cdot}64913$ gm./cm.^{3}. The grating space given by A. H. Jay[14] at 18° C. is $a = 4{\cdot}9029$ A. or $a' = 4{\cdot}91285 \times 10^{-8}$ cm., and $c = 5{\cdot}3933$ A. or $c' = 5{\cdot}40425 \times 10^{-8}$ cm.; from the equation: $6.M_{\text{SiO}_2} = 3.N_A \cdot \rho_{\text{SiO}_2} \cdot a'^2 \cdot c'$, and substituting the various numerical values, we find $M_{\text{SiO}_2} = 60{\cdot}081$. Therefore the atomic mass of silicon is:

$$Si = 28{\cdot}081.$$

This value is close to that found by several authors (Si = 28·087)[15] with the mass-spectrograph, but higher than the one accepted by the International Commission, namely, Si = 28·06.

Arsenic trioxide (octahedric). By the pyknometric method, C. Gutierrez Losa has found for the density at 0° C. of a very pure sample of As_4O_6 the value $\rho^0 = (3 \cdot 8776 \pm 0 \cdot 0002)$ gm./cm.^{3}. Taking as coefficient of cubic expansion[16], between 0 and 25° C., $\alpha = 9 \cdot 3 \times 10^{-5}$, the density at 23° C. will be $\rho^{23} = 3 \cdot 8694$ gm./cm.^{3}. The grating space of octahedric As_4O_6 has been measured with great accuracy by Straumanis and Ievins[17], who found at 23° C. $d^{23} = 11 \cdot 0521$ A. or $d'^{23} = 11 \cdot 0745 \times 10^{-8}$ cm. Using the formula $8.M_{As_4O_6} = N_A . \rho_{As_4O_6} . d'^3_{As_4O_6}$, and substituting the numerical values, gives $M_{As_4O_6} = 395 \cdot 68_6$, and for the atomic mass of arsenic,

$$As = 74 \cdot 92_0 .$$

Galena (PbS). The measurements at 0° C. carried out by C. Gutierrez Losa with galena from Puertollano (Ciudad Real, Spain), carefully selected so as to remove all the quartz, gave for the density of lead sulphide $\rho^0 = (7 \cdot 6068 \pm 0 \cdot 0004)$ gm./cm.^{3}. Taking for coefficient of cubic expansion[18] $\alpha = 6 \cdot 04 \times 10^{-5}$, the density of galena at 18° C. will be $\rho^{18} = 7 \cdot 5985$ gm./cm.^{3}. The grating space of very pure galena has been measured by E. von Zeipel[19] at 18° C. : $d^{18} = 5 \cdot 9232_4$ A. or $d'^{18} = 5 \cdot 92526 \times 10^{-8}$ cm. Using the formula $4.M_{PbS} = N_A . \rho_{PbS} . d'^3_{PbS}$, and substituting the several numerical values, we find, $M_{PbS} = 239 \cdot 22_5$; hence, subtracting S = 32·066, the result for the atomic mass of lead is,

$$Pb = 207 \cdot 16 .$$

From the various results obtained for the atomic masses studied, we conclude that the pykno-X-ray method for determining atomic masses is very satisfactory. On the other hand, the method would be much more accurate if the crystal densities and grating space measurements had been measured *at the same temperature* and, if possible, *with the same sample*. Accordingly, all future work on this subject in this Laboratory will be carried out on this basis.

Finally, it would be better to take as reference standard instead of calcite another substance such as diamond. Then, of course, the value used for the Avogadro number would be that deduced from diamond. Calcite has been adopted here because in our opinion its density, grating space and structural geometrical constant have been determined with greater accuracy than any other crystalline solid.

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PREFERENTIAL RELEASE OF ASPARTIC ACID DURING THE HYDROLYSIS OF PROTEINS

By Dr. S. M. PARTRIDGE and H. F. DAVIS

Low Temperature Station for Research in Biochemistry and Biophysics, Cambridge

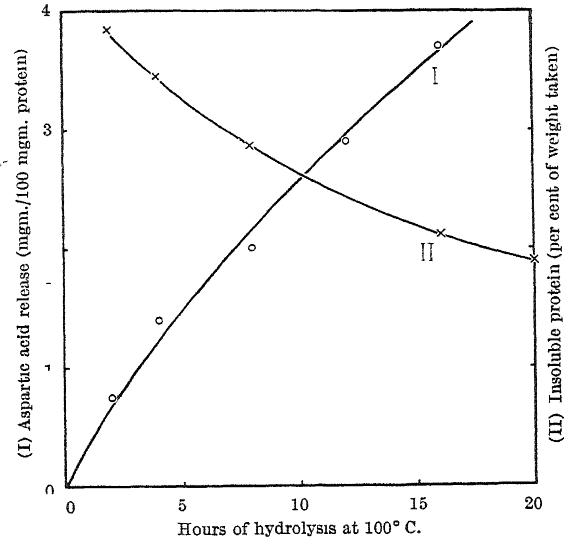
DURING a study of the progress of hydrolysis of ovomucin and ovomucoid, it was observed that aspartic acid was preferentially released from the protein moiety of these mucoids on partial hydrolysis with acetic acid or oxalic acid at 100° C. The effect was not confined to the mucoids and has since been observed with proteins of several other classes, including egg albumin, edestin, insulin and gelatin. In a typical experiment, weighed samples of protein were heated for varying periods of time with 0·25 *M* aqueous oxalic acid in sealed glass tubes at 100° C. Oxalic acid was removed by neutralization to *p*H 4 with barium hydroxide, and the large protein fragments remaining were precipitated by the addition of three volumes of ethanol. The supernatant 75 per cent alcoholic solution, containing the smaller protein fragments and any free amino-acids liberated during the course of the hydrolysis, was evaporated to dryness under reduced pressure. The solid residue was made up with a known volume of water and used for qualitative and approximate quantitative analysis by filter paper chromatography. The accompanying table illustrates qualitatively the release of aspartic acid, glutamic acid and other amino-acids from various proteins, and it is to be noted that, in all cases except those of ovomucin and gelatin, aspartic acid was the only amino-acid to be released in substantial quantity during the first eight hours of hydrolysis.

RELEASE OF ASPARTIC ACID, GLUTAMIC ACID AND OTHER AMINO-ACIDS FROM VARIOUS PROTEINS ON HYDROLYSIS WITH 0·25 *M* OXALIC ACID

		Hours hydrolysis			
		2	4	8	16
Insulin	aspartic acid	+	++	+++	++++
	glutamic acid				(+ –)
	other amino-acids				(+ –)
Edestin	aspartic acid	+	++	+++	++++
	glutamic acid			(+ –)	+
	other amino-acids				+
Egg albumin	aspartic acid	+	++	+++	++++
	glutamic acid			(+ –)	+
	other amino-acids			(+ –)	+
Gelatin	aspartic acid	+	++	+++	++++
	glutamic acid			+	++
	other amino-acids		(+ –)	++	++++
Ovomucoid	aspartic acid	+	++	+++	++++
	glutamic acid				+
	other amino-acids				+
Ovomucin	aspartic acid	+	++	+++	++++
	glutamic acid			+	++
	other amino-acids		(+ –)	++	++++

Key: (+ –), trace; +, weak spot; ++, fairly strong spot; +++, strong; ++++, very strong.

The graph shows the release of aspartic acid from recrystallized ovalbumin on hydrolysis with 0·25 *M* oxalic acid at 100° C. No other amino-acids were detected after the first eight hours hydrolysis; but at sixteen hours weak spots due to glutamic acid and other amino-acids appeared on the paper chromatograms. The graph also shows the amount of protein precipitable by 75 per cent ethanol at various times during the course of the hydrolysis, and it is clear from inspection of the curves that release of aspartic



(I) Release of aspartic acid; (II) protein remaining insoluble in 75 per cent ethanol

acid is accompanied by a closely corresponding reduction in the amount of material remaining as particles of high molecular weight.

If we consider the hydrolysis of a peptide chain by means of a weak organic acid, the *p*K of the acid does not greatly differ from the *p*K of any free carboxyl groups that may be present in the chain. These groups are thus partly undissociated and may serve as a local source of hydrogen ions capable of effecting the hydrolysis of adjacent peptide bonds, but inactive against other peptide bonds situated at greater distances. Aspartic acid and glutamic acid residues in proteins are frequently in the amide form, and thus the free —COOH group is masked; but since the acid hydrolysis of such amides is rapid[1,2], the release of free carboxyl groups should occur early in the hydrolysis. Once released, the side-chain carboxyl of aspartic or glutamic acid is free to act as a proton donor and to promote the hydrolysis of the peptide links involving α-carboxyl. If this occurs, release of the α-amino-group should proceed rapidly, since there are then available two free carboxylic acid groups capable of promoting the hydrolysis.

The same kind of argument applies to the free carboxyl at the end of the peptide chain, and if the argument is valid, hydrolysis of a peptide not containing dicarboxylic amino-acids should proceed by stepwise removal of the terminal member of the chain. Partial hydrolysis should thus result in the production of free amino-acids together with a peptide residue of reduced chain-length. This is in sharp distinction to the effect of hydrolysis with strong mineral acids at low temperatures, where the resulting product is mainly dipeptide in character[3], and there is evidence that the peptide linkages involving the amino-groups of serine and threonine are the least stable[4]. On hydrolysis with weak organic acids, release of the dicarboxylic amino-acids would be expected to be particularly rapid where these occur as terminal members of the chain or where they occur in sequences occupying adjacent positions with respect to one another.

The accompanying table shows that glutamic acid is in each case one of the first amino-acids, after aspartic acid, to be released in substantial quantity. The release of aspartic acid at an earlier stage than glutamic acid is to be expected, since the values of pK_1 and pK_2 are both considerably lower in the case of the former.

It is noteworthy that di- and tri-peptides were not found in the early stages of the hydrolysis, and also that the neutral amino-acids appear before the bases. This was demonstrated by the following experiment. A sample of ovalbumin was hydrolysed by means of 0·25 *M* oxalic acid for sixteen hours, and the fraction soluble in 75 per cent ethanol was concentrated and used for the preparation of two-dimensional chromatograms. The results showed the presence of a high concentration of aspartic acid and, in addition, weaker spots due to glutamic acid, serine, glycine, threonine, alanine, valine and leucine appeared on the chromatograms. Spots due to the basic amino-acids were not observed, and small peptides giving the ninhydrin reaction also seemed to be absent. However, a fairly large part of the hydrolysis product was in the form of large polypeptides which gave no colour with ninhydrin. This material was demonstrated by eluting (with water) a cut portion of the paper chromatogram. After hydrolysis with 5·5 *N* hydrochloric acid, the eluted material was found to contain all the amino-acids originally present in the protein but was low in aspartic acid content. The free amino-acids released by partial hydrolysis with oxalic acid may be residues occupying the terminal positions in the various chains initially present in the protein, together with the terminal members of the various chain fragments produced by early rupture.

It may be appropriate to remark here that the conversion of collagen to gelatin is not accompanied by the liberation of aspartic acid, although the amino-acid is released on further degradation of the gelatin. In an experiment to test this point, a sample of finely powdered collagen prepared from bovine tendon was heated with 0·1 *M* oxalic acid at 80° C. In two hours conversion to gelatin was complete, but the 75 per cent alcohol-soluble fraction showed only a trace of aspartic acid.

The preferential release of aspartic acid on hydrolysis with weak organic acids is of particular interest since it may offer a means of breaking a protein molecule at specific points in the peptide chain. From our results it appears that three main fractions are obtained from partial hydrolysis with organic acids: (*a*) protein fragments of colloidal size; (*b*) polypeptides of high molecular weight which give no colour with ninhydrin; (*c*) aspartic acid, together with much smaller quantities of other amino-acids. Fraction (*a*) is suitable for further fractionation by electrophoresis, and in an exploratory experiment it was found that fraction (*a*) from partially hydrolysed insulin gave several well-defined peaks in the electrophoresis apparatus of Tiselius. However, the most interesting results are likely to be obtained from the analysis of fraction (*b*); but this must await the development of fractionation procedures suitable for large polypeptides of this kind. An attempt is now being made to apply these findings to a study of the mucoids and proteins of white of egg.

The work described in this communication was carried out as part of the programme of the Food Investigation Organisation of the Department of Scientific and Industrial Research.

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MECHANISM OF ELECTRO-POLISHING

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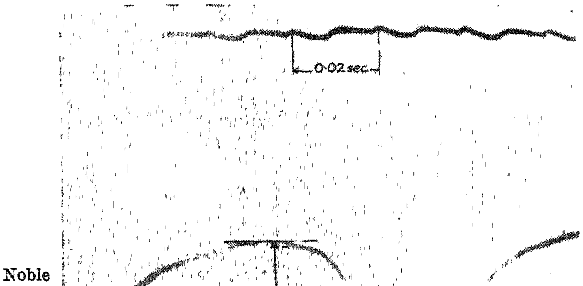
THE production of a specularly reflecting surface by anodic attack on an initially rough metal involves: (*a*) the selective removal of metal from the asperities rather than the depressions, and (*b*) the avoidance of the formation of etch figures on the smoothed surface. Many authors have laid emphasis on the first phenomenon, and it has been explained rather vaguely as a consequence of the formation of a layer of high electrical resistance in the liquor next to the dissolving metal; the second phenomenon, although of equal importance, has been relatively ignored.

Studies in the electropolishing of nickel, to be reported in detail elsewhere, have led us to formulate the following hypothesis for its mechanism, which we believe may prove to have general application.

When nickel is made anodic in, for example, a 50/50 sulphuric acid/water bath (with or without glycerine additions), electropolishing occurs if the current density is high enough[1]. Ordinary anodic dissolution to an etched surface, however, occurs at first, and a time interval is required (shorter the higher the current density) before polishing conditions are set up; there is a small slow rise of anodic single potential during this time interval and a large rapid one at its end, whereupon polishing begins. During the time interval, streamers of green Ni_{aq}^{++} flow from the anode, and accompanying this production of dissolved nickel, powdery, nearly white crystals of $NiSO_4$ (anhydrous) and $NiSO_4.H_2O$ (shown by chemical and X-ray analysis) and sometimes a black film (possibly NiO or a partially hydrated form) appear on the anode; the black film flakes off at or about the time of the potential rise, but the white crystals and green streamers continue to be produced during polishing, and at the same time some oxygen is evolved, the more rapidly the higher the current density.

These phenomena are strikingly similar to those established by Müller for the onset of the anodic passivity of nickel[2], iron and other metals in less concentrated sulphuric acid. Müller suggested that the initial production of a relatively loose layer of solid corrosion products, formed by precipitation from saturated solution, leads after a time interval to a very high current density locally at the base of pores in the layer. This produces passivity, with evolution of oxygen and cessation of metal dissolution, the original loose layer of corrosion products becoming dissipated. Müller at first attributed passivity to an interior change in the metal, but later, after Evans had isolated very thin compact oxide films from anodically passivated metal[3], adopted the now accepted theory that it is caused by the formation of a compact oxide film.



Oscillation of anode potential at lowest current density giving polishing. Upper trace, time; lower trace, electropolishing oscillations

We believe that the rapid rise of potential observed at the onset of electropolishing is also due to the similar formation of a compact oxide film on the metal surface, but that the crucial difference between the electropolishing and passive conditions is that the compact film is readily dissolved by the more concentrated acid necessary for electropolishing, dissolving, indeed, as fast as it is formed and, in the case of nickel, never reaching a thickness of more than a few unit cells. Such a film would allow the observed discharge of oxygen at its surface (such discharge at a bare metal surface, without oxide formation, is inconceivable), but would be undetectable either by film-stripping or by electron diffraction. It would also, if very thin, allow easy transport of nickel ions through it by lattice diffusion; and their continual removal as aquo-ions from its outer surface would allow the process of polish attack to continue.

Moreover, the conception of nickel metal 'dissolving' into a solid oxide lattice, not immediately to aquo-ions, explains why etch figures on the metal surface are not formed. For etching, it is necessary that selective removal of atoms from certain lattice portions occur, so that definite lattice planes are formed as surfaces of the etch figures. This is to be expected when normal dissolution to dissolved aquo-ions proceeds, since the energy-hump for the dissolution process will be least for particular lattice positions. But when the actual anodic process is the transfer of the metal atom from the metal lattice into a lattice-defective solid oxide film, it is the random distribution of lattice vacancies in the oxide film next to the metal that will decide which metal atoms can at any instant undergo the process; a metal atom in the favourable position for dissolution into a liquid medium can scarcely 'dissolve' if there is no adjacent vacant site in the film, and conversely, one in a normally unfavourable position will dissolve relatively easily if there is an adjacent vacant site in the film. Thus the production of a specular surface without etch figures, consequent upon the random anodic removal of metal atoms, is readily explained by the present theory.

When a constant current density only just large enough to produce electropolishing (of nickel in the sulphuric acid bath) is applied, violent oscillations of the potential difference across the bath (that is, of the anode single potential, since the cathode single potential and the electrolytic ohmic drop are constant) are noticed just after the rapid potential rise; this phenomenon has often been observed for many cases of electropolishing, and the rather similar but slower oscillations found in cases of anodic passivity have been studied in detail by Müller[2] and by Hedges[4]. By using a 110-v. direct current source and a large rheostat in series with the cell, we have been able to adjust the current density to a suitable, almost constant, value (c. 0·06 amp./cm.^{2} at 35° C.) at which the potential difference oscillations can be maintained almost indefinitely. Using a high-gain pentode D.C. amplifier and a double-beam cathode-ray oscillograph with a very slow time-base, we have obtained the accompanying record, which shows about one and a half of the oscillations, the magnitude and speed of which are remarkable; the potential difference rises by c. 1 v. in c. 0·06 sec. and falls again in c. 0·02 sec.

The oscillations are readily explained in terms of the present theory as follows. The rise of potential is due to the growth of the very thin passivating oxide film, its rate of anodic formation from the metal being greater than its rate of dissolution; as this forms, oxygen can be discharged at its surface as an alternative anodic reaction, so the current density available for film formation diminishes. The rate of film formation thus becomes less than the (constant) rate of dissolution, and the film disappears, giving a fall of potential to that characteristic of active metal. Oxygen now ceases to be discharged, film-building again takes over, and so the process goes on. Calculation shows that the thickness of film formed before dissolution supervenes can be only of the order of a few unit cells.

We may note that many electropolished metals behave, from a corrosion or tarnishing point of view, as if a very thin compact oxide film is left after polishing; in some cases, for example, aluminium, a relatively thick compact film has been demonstrated microscopically[5]. We believe that the present hypothesis for nickel may be quite general qualitatively, differences in different metals arising from differences in the electrical conductivity and ease of dissolution of the oxides, which would lead to varying thicknesses in the steady-state electropolishing films.

The much-discussed 'smoothing' effect in electropolishing, consequent on the dissolution of asperities, is also readily explained in terms of Müller's theory of anodic passivity. The relatively thick, mobile layer of saturated solution and solids forms before the 'passive' film has been produced, and in electropolishing continues to form (perhaps with modified composition) and to dissipate afterwards. It will clearly be both thicker and less disturbed in the hollows on the surface than on the asperities. Because it is *thicker*, the current density in the hollows will be the less from ordinary considerations of ohmic resistance, which may be expected to be reasonably high for a layer containing much solid. Because it is *less disturbed*, we may expect conditions for passivity to be reached sooner in the hollows than on the asperities, and the consequent great increase in anodic polarization in the hollows will divert most of the current to the asperities. The former reason for smoothing has often been urged; we believe the latter, first clearly stated by Evans[6], may be much the more important.

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A CULTURE METHOD FOR GROWING SMALL FREE-LIVING AMŒBÆ FOR THE STUDY OF THEIR NUCLEAR DIVISION

By DR. B. N. SINGH

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THE genera and species among the small free-living, intestinal and parasitic amœbæ have been largely created by previous workers on the basis of their nuclear structure and their mode of nuclear division. A review of the literature on the nuclear division in small free-living amœbæ clearly shows great confusion in the cytological investigations carried out by the different workers. This has been due to two principal reasons: first, the difficulty of getting the various normal stages of nuclear division on account of the lack of suitable cultural conditions; and secondly, the use of cytological techniques which are not specific for the location of chromatin and non-chromatic materials during all the stages of nuclear division. This has resulted in the creation of a large number of species of small free-living amœbæ, the great majority of which can only be identified by those who described them.

In the past, small free-living amœbæ have usually been grown for the study of their nuclear division in nutrient liquid media with uncontrolled bacterial food supply. Two main methods have been used for making cytological preparations: (1) cover-slips were put at the bottom of the liquid media for amœbæ to grow on them; (2) coverslips were also floated at the top hoping that amœbæ would crawl over them and multiply. After various intervals the cover slips were removed and cytological preparations were made. The suitability of such methods for getting the stages of nuclear division can be judged by the following remark of Dobell[1], who took great pains to study the nuclear division in free-living amœbæ; he says (p. 146): "I may add here that chance plays a large part in determining the success—or the reverse—which rewards the efforts of those who try to study the methods of division in many species of amœbæ".

A method is described below which enables one to get easily all the stages of the nuclear division in small free-living amœbæ. It was first developed by me[2] in connexion with the work on *Leptomyxa reticulata* Goodey and has been found suitable for the study of the nuclear division in large numbers of species of amœbæ isolated from soil and fresh-water during the past four years. It is hoped that the method described here may lead to a more satisfactory way of classifying, at least, the small free-living amœbæ by the study of the nuclear divisions of a large number of species under controlled cultural conditions and with suitable bacterial food supply. Moreover, the method as presented here or in a modified form is applicable to the study of the cytology of other groups of Protozoa and other micro-organisms.

'Pure mixed' cultures starting from single cysts or single trophic forms were obtained on non-nutrient agar (1·5 per cent agar in 0·5 per cent sodium chloride; pH 6·6–7·0) plates supplied with a young culture (2–5 days old grown on nutrient agar slopes) of *Aerobacter* sp.[3], strain 1912, as food supply. This bacterium has been found to be one of the best sources of food for soil amœbæ and other groups of micro-predators during an extensive study of the selection of bacterial food by several groups of soil holozoic organisms during the past ten years. The single cysts or the trophic forms were washed at least six times in 0·5 per cent sodium chloride by transferring them from one washing to the other by separate micropipettes. All precautions were taken to work under sterile conditions. After several sub-cultures, each sub-culturing being done after four to seven days, pure-line cultures were once again started from single cysts. All the species of small amœbæ so far isolated either from soil or from fresh-water have been found to grow exceedingly well on *Aerobacter* sp. Amœbæ that were required for cytological preparations were sub-cultured every 24 or 48 hours, depending on their rate of growth and multiplication, for a few days in order to get healthy, young and actively dividing forms. They were then grown on non-nutrient agar films by the method described below.

Thin films of non-nutrient agar were made on slides as follows: one or two small drops of hot melted agar (1·5–2 per cent depending on the quality of agar) were spread as a thin film by quickly covering with a No. 1 ⅞-in. or slightly larger coverslip. When the agar had solidified, the coverslip was gently pushed from one side and removed from the slide with the help of a pair of fine forceps, leaving the film on the slide. With some practice it is easy to make a film on a slide within three to five minutes. A thin piece of agar all around the film is then cut off to get rid of the excess agar that had come out of the coverslip. This also helps in removing the whole film under water, at a later stage. Now one or two loopfuls of a thick suspension of a young culture of *Aerobacter* sp. in 0·5 per cent sodium chloride were gently smeared on the agar surface, and mass inoculation of young and actively dividing amœbæ from the agar plate was made on the film. The slides were kept in moist chambers in Petri dishes in order to prevent the drying of the agar films, and were incubated at 20–21° C. Every precaution was taken to prevent the contamination of the film. Usually six to eight film cultures were made from each strain of amœbæ at about 7 p.m. and the films were fixed the next day in suitable fixatives; each film culture was fixed at an interval of an hour, starting from 10 a.m. The slides were put into the fixative with the film surface downwards, and after a minute they were gently turned over. The slides after the fixation for a suitable length of time were put into 90 per cent ethanol for 24 hours, and then they were brought through 70, 50 and 30 per cent ethanol for a few minutes each to distilled water. At this stage the film of agar was removed by giving a gentle shake to the slide. A large percentage of amœbæ usually remain stuck to the slide after the removal of the film. It seems that amœbæ sink through the agar and remain stuck to the glass when the film is removed after fixation. The amœbæ were then stained and permanent preparations were made in the usual way.

By the above method large numbers of normal, young and actively dividing amœbæ ranging from 15 hr. to 23 hr. old can be found on a single slide. As they are confined to a small area on the slide, it is easy to find dividing individuals in all stages under the oil-immersion lens. It must be pointed out that some practice and patience is necessary to use this method successfully.

The nuclear division in twelve strains of amœbæ, consisting of at least nine distinct species, has been studied by the above method. The various stages of nuclear division could be obtained whenever desired. There is no need to rely on chance to get stages of nuclear division, as was the case with the methods used by previous workers. The study of the nuclear cytology in small free-living amœbæ and its bearing on the classification of amœbæ will be published elsewhere. It may be pointed out here that the mode of nuclear division of those amœbæ falls into two main types. There is no such great diversity in the nuclear division among the different species belonging to these groups as one was led to believe, for much of the previous work was often based on too few species or on unsuitable techniques. The study of adequate numbers of dividing cells by the above method, combined with selective staining methods, will doubtless result in a great simplification of the present classification of these forms.

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GENERATION AND ANALYSIS OF ULTRASONIC NOISE

By Dr. S. C. GHOSE
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A GREAT deal of research work has been carried out in recent years on the physiological effects of audible noise from aero-engines and aircraft in flight. About two years ago, the Acoustics Laboratory of the Department of Otorhinolaryngology, Central Medical Establishment, Royal Air Force, undertook the study of the inaudible component of noise or ultrasonics produced by turbo-jet aircraft in flight and turbo-jet engines on test beds. The project was considered under two headings: (1) analysis of the ultrasonic noise thus produced; (2) generation, in the laboratory, of this ultrasonic noise at high intensity, to determine what physiological effect it has on living organisms.

As no suitable apparatus for carrying out these investigations was available in Great Britain, its design and construction was the first task of the

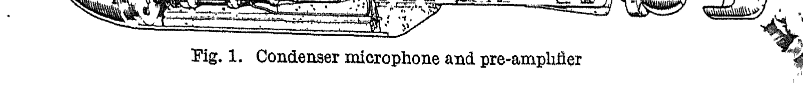

Fig. 1. Condenser microphone and pre-amplifier

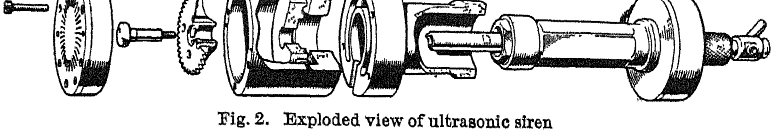

Fig. 2. Exploded view of ultrasonic siren

Laboratory. The major items required were: (*a*) one or two miniature microphones, operating up to a frequency of at least 100 kc./s., and their associated special amplifiers, together with a wave analyser covering the same range; (*b*) a range of Hartmann generators covering the same frequencies to determine the sensitivity of the microphones by comparison with a calibrated standard; (*c*) a siren that would generate the ultrasonic noise at a high intensity for the physiological experiments.

Ultrasonic Microphones. Several microphones were designed and produced. The most satisfactory ones were calibrated against the 'Brush *BM.* 101' hydrophone and used in all the experiments. Both piezo-electric and condenser types were tried, and finally one of each was selected. Fig. 1 is a cut-away drawing of the condenser microphone, with its head amplifier and output/supply cable. This instrument possesses a fairly even response up to 100 kc./s., and its polar diagram in the plane of the diaphragm is close enough to a circle for the slight discrepancies, due to the incident sound, to be ignored.

For calibration, the sound pressure at a wide variety of frequencies, produced by a suitable generator operating under fully controlled conditions, was measured by the hydrophone. The hydrophone was replaced in turn by each of the microphones being calibrated. Their output was noted, and thus was established the relationship between incident sound pressure and voltage output throughout the required frequency-range. From the foregoing it can be seen that all measurements of sound (audible or otherwise) were made indirectly.

The Hartmann generators are pure acoustic devices which operate on a principle similar to that of a Galton whistle. Each generator consists of a jet through which compressed air issues into a resonator. The rapid 'filling up' and 'spilling over' of the resonator produces oscillations, at a frequency dependent upon the physical dimensions of the jet and resonator, and to a lesser degree on the distance between them. Thirty-five of these generators were made to cover the frequency-range at intervals of 3 kc./s.: they were assembled on a calibration stand so that they were radially disposed around the microphone at a distance of 100 cm. from it.

Ultrasonic Siren. If compressed air is forced through a slot which can be opened and closed at high speeds, puffs of air having a high acoustic-energy content are produced; the frequency of the note thus generated is the number of times per second the slot is opened and closed. This principle is utilized in the ultrasonic siren; it is not, however, a simple matter to open and close a slot at sufficient speed to produce pressure waves at a frequency of the order of 100 kc./s. Accordingly, several slots are arranged circumferentially in the flat end of a totally enclosed cylinder. A toothed disk is rotated behind these slots so that its teeth alternately open and block off the slots; the frequency of the note thus produced is the product of the number of slots and the number of revolutions per second of the toothed disk.

As can be seen from Fig. 2, this is what has been done in the case of the siren designed in this Laboratory. Three stator and rotor sets giving a maximum energy output at 25 kc./s., 50 kc./s. and 100 kc./s. have been made; the rotor in each case is driven by a compressed-air motor which has a maximum speed exceeding 36,000 r.p.m. The volumetric air consumption of the siren is of the order of 100–120 cu.ft. per min. at a pressure of not less than 125 lb./sq. in.

Analysis of Ultrasonic Component of Noise. Measurements of the intensity at varying frequency of ultrasonics arising from jet engines on test beds and jet aircraft in flight at a speed not higher than 300 m.p.h. have shown that ultrasonics are present up to a frequency of at least 100 kc./s. The intensities so far measured, however, are not of such magnitude as to cause any harm to ground personnel or aircrew. It is anticipated that with airspeeds approaching the speed of sound, the ultrasonic 'noise' intensities may be high. The major part of the ultrasonic 'noise' produced under these conditions of flight is aerodynamic in origin.

Thanks are due to the Director-General of Medical Services, Royal Air Force, for permission to publish this article.

GERMAN HYDROGRAPHIC INSTITUTE, HAMBURG

ANNUAL REPORT

THE German Hydrographic Institute in Hamburg (which, since the constitution of the German Federal Republic, comes no longer under the Bizonal Administration but under the Federal Government) has recently issued its report* on the third year (1948) of its activity. This runs to sixty-six pages of text, eight charts, one page of sketches and seven illustrations. In addition to a report on general changes and events in the section for organisation, this volume contains *inter alia* details of "Sailing Directions", lists of lights, and lists of radio signals as well as of charts. An account is given of the wreck-locating operations and of the areas in the German Bight surveyed by the sounding boats of the Institute.

In the year under report, the Institute joined with the fishery biologists in making investigations in the field of oceanography, and, in respect of coastal waters, it resumed work directed to the protection of the coast in co-operation with the appropriate institutions. Its Geomagnetic Service has worked up and issued the magnetic observations for the year 1943 made by the Institute's Geomagnetic Observatory at Wingst. Tide tables and nautical year-books are, it is understood, issued by its Department of Tides once a year. In 1948, twenty-two ice reports were issued, and thirty-two storm tide warnings relating to thirty days were promulgated. The Department of Nautical Engineering continued to improve nautical instruments (magnetic and gyro compasses among them) and, in addition, checked a great number of nautical instruments for shipping interests.

The progress attained in re-establishing the exchange of publications with foreign countries is very naturally referred to with satisfaction. A comprehensive index, showing the official publications of the German Hydrographic Institute as well as the work of the scientific staff, is given as an appendix. The index and the index charts giving information about German "Sailing Directions" and charts which have been published, put in hand, or decided upon, replace the "List of Books and Charts" previously issued by the former German Navy. Though the German Hydrographic Institute was not able to open any more agencies in 1948, it has increased the number of official sale agencies which it keeps supplied with charts and navigation books.

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* Annual Report No. 3, 1948. German Hydrographic Institute. (Authorized by the Allied Control Council for Germany.) Pp. 66. (Hamburg, 1949.)

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Development of the Universe

THE theories of Mr. F. Hoyle and Prof. Pascual Jordan have renewed an interest in an important cosmological problem: How and when did the substance of the material universe come into existence? It may facilitate discussion if the difficulties in the way of the various theories about this are summarized in the simplest possible terms.

The difficulty in the theory that all the matter in the universe has existed for an infinite time is that it would then have reached certain limiting conditions, limits, for example, of concentration; of entropy; of radius of curvature of an expanding universe. Mathematical analysis has shown that no such limits have been reached.

The difficulty in the assumption that all the matter in the universe has existed for a finite time is of a different kind. The assumption depends on the hypothesis that two moments in time have had a peculiar significance. One is the moment when matter first began to appear, the other the moment when the process of appearance stopped. This assumption is further based on the hypothesis that, while holding rigidly now in such a way as to cause the total energy in the universe to be constant, the principle of conservation of energy did not hold in the same way during the period between the two above-mentioned hypothetical moments of time.

One of several difficulties in Prof. Jordan's theory is the underlying hypothesis that 10^{60} protons can have a real existence for a definite period of time before, in the form of a star, they emit a signal by which they could be detected. Mr. Hoyle's theory, though it has the advantage of simplicity, raises one grave difficulty. If interstellar space had been witnessing the appearance of matter for an infinitely long time, an infinite amount of it would have followed a gravitational field in the direction of such large accumulations as the nebulæ. So these would have reached infinite size.

This latter difficulty would be overcome if one assumes that the continuous appearance of matter is accompanied by its continuous disappearance; though both processes need not be at the same rate. If so, the present increase in the total contents of the universe postulated both by Hoyle and Jordan is a differential effect. This assumption contains, I think, a minimum of hypothesis. It does not postulate the simultaneous appearance of any specific or even large numbers of protons, and allows for the possibility that single small particles may appear at any given time or place. It does not postulate that any given region in space is more privileged than any other to be the site of the appearance of a new particle, and it does not postulate that any existing particle is more privileged than any other to disappear at a given moment.

The automatic results of such completely random appearance and disappearance would be that most new matter would come into existence in interstellar space, while most disappearances would occur in concentrations such as the nebulæ. Thus these would be continuously renewed and roughly compensated for the matter that has fallen, as it were, through them out of existence.

If matter is both appearing and disappearing at all times completely at random, the second Law of Thermodynamics will not lead to an infinite increase in entropy, for the increase will be counteracted by the potential energy of new matter in interstellar space. The net increase need not always be positive. It could sometimes be negative and cause a reversal of the present expansion of the universe. While this was happening, the total mass of nebulæ as well as individual stars would tend to diminish, and it should be possible to show that there is a maximum concentration above which disappearances are more rapid than appearances, so that concentrations of matter can only vary between specific limits.

Lastly, there appears to be some misapprehension concerning the bearing of the principle of conservation of energy on cosmological theories. This principle states that in a self-contained system the total amount of energy is constant. If matter may appear or disappear at random, the conclusion is that, in practice, one cannot be sure of ever having a self-contained system, not that the principle does not hold.

REGINALD O. KAPP

University College,
London, W.C.1. Oct. 21.

IN the system of cosmology I have advocated, and also in the parallel theory of Bondi and Gold, the nebulæ are not all of infinite age as Prof. R. O. Kapp seems to imagine. In a sufficiently large volume V cm.^{3} of space, the number of nebulæ with ages greater than T (T being measured in units of Hubble's constant, namely, $1 \cdot 8 \times 10^9$ years) is about $10^{-72} V e^{-3T}$, the average spacing between nebulæ older than T being about $10^{24} e^T$ cm. By taking V large enough, it is true that a nebula of arbitrarily large T can be found. But this has little interest when related to astronomical observation, for the effect of the red shift of light, arising from the expansion of the universe, is to make the observation of events occurring at distances greater than about $1 \cdot 7 \times 10^{27}$ cm. inherently impossible (even for an observer equipped with a perfect telescope). It follows, therefore, that the oldest nebulæ within the observable portion of the universe have ages T given, so far as order of magnitude is concerned, by

$$10^{24} \exp T = 1 \cdot 7 \times 10^{27},$$

that is, $T = 7 \cdot 44$ Hubble units $= 1 \cdot 34 \times 10^{10}$ years. These nebulæ have been identified tentatively with the nebulæ in the great clusters. It may be noted in passing that a specially chosen observer can detect *one* condensation having an age T appreciably greater than the value given by the above equation. But the probability of this occurring for an observer taken at random decreases with increasing T according to the factor $\exp - 3T$.

The above remarks summarize results which show that, although condensations of increasing age and size can occur, their distances from the observer increase correspondingly. This has the effect of making very old nebulæ optically unobservable, and also of making negligible their influence on the metric in the portion of the universe accessible to the observer.

It appears, therefore, that Prof. Kapp's objection concerns a question that has no relation to observation. A similar remark applies to an issue raised by Prof. Jordan in *Nature* of October 15, 1949, p. 637. He points out that my work leads to the conclusion that there must be an inter-nebular medium in which the material density is about a hundred times greater than the smoothed-out average density of the nebulæ themselves. He goes on to dismiss this requirement on the grounds that it finds no favour with observational astronomers. Now I stated explicitly that on my theory the inter-nebular medium consists effectively of hydrogen, which has negligible scattering effect on the light received from even the most distant nebulæ observed. Moreover, a uniform inter-nebular medium has no effect on the peculiar motions of the nebulæ. Thus there is no way in which such a medium can be directly observed, and, accordingly, one is left wondering under what canon of logic Prof. Jordan refers the issue to observational astronomy for a decision.

I also find it difficult to understand why Prof. Born raised the question of the conservation of energy, for one of the most striking results of my work, and also of the work of Bondi and Gold, is that the large-scale features of the universe are independent of time. The conservation of energy is a trivial consequence of this result.

It remains to consider objections to the suggestions made by Prof. Jordan and Prof. Kapp. If the matter of the universe originates in large explosive lumps, identified by Prof. Jordan as supernovæ, it is difficult to understand why the diffused matter is observed to be concentrated in nebulæ instead of being more or less uniformly distributed, and also why the supernovæ are apparently confined to the nebulæ instead of being uniformly distributed throughout space. There is also the serious difficulty that the observed rate of supply of material by the novæ and supernovæ is far too small to be cosmologically significant, amounting as it does to only about one-thousandth of the masses of the nebulæ in a time equal to one Hubble unit ($1\cdot8 \times 10^9$ years). Also the material emitted from supernovæ almost certainly has a very different chemical composition from the material comprising the nebulæ (which are largely composed of hydrogen). The temperatures and densities in supernovæ are so high that nuclear reactions take place very rapidly, and it is to be expected that their effect is to leave the material far poorer in hydrogen content than normal interstellar material.

Turning now to Prof. Kapp's interesting suggestion, if the disappearance of matter in dense condensations were at all comparable with the required rate of appearance of matter in inter-nebular space (this rate being fixed so as to get the observed rate of expansion of the universe), then, as can be shown, every dense body, such as a planet or a star, must lose half its mass in less than 10^9 years. A rapid decrease of mass of this order can scarcely be reconciled with astronomical and geophysical data.

F. Hoyle

St. John's College,
Cambridge.

A High-Efficiency Neutron Detector

The recent development of scintillation counters as high-efficiency detectors of gamma-radiation makes attractive the possibility of detecting neutrons by means of the γ-rays produced in many neutron-induced reactions. Particularly interesting is the detection of the 480-keV. γ-ray given off by the excited lithium-7 in the reaction:

$$B^{10} + n \rightarrow Li^{7*} + He^4$$
$$Li^{7*} \rightarrow Li^7 + \gamma \text{ (480 keV.)}.$$

Ninety-three per cent[1] of the intermediate boron-11 nuclei decay via this excited state of lithium-7. We have detected the γ-rays from this reaction and also from the (n,γ) reactions in cadmium, indium and samarium.

The Harwell crystal spectrometer was used for providing a source of mono-energetic neutrons with a comparatively low proportion of accompanying γ-rays. The sample was placed in the beam of neutrons diffracted from a calcium fluoride crystal. The scintillations produced by the resultant γ-rays in an anthracene crystal were detected by an R.C.A. 931A. photo-multiplier tube. The counter was protected from the intense background of neutrons and γ-rays from the pile by successive shields of lead, cadmium and paraffin wax.

The efficiency of the counter remained constant with all samples, except the indium, for neutrons with energies lying between 0·04 and 0·2 eV. The indium sample was the only one which was not 'black' over this range. The detection efficiency for boron was approximately 1 per cent, and for the other samples about 4 per cent. The comparatively low efficiency of boron is largely due to the fact that only one γ-ray is produced for every neutron captured, while several γ-rays are given off in the (n,γ) reactions in cadmium, indium and samarium. However, in the energy region above a few hundred electron volts, where this detector is likely to be of most value, the boron cross-section is well known.

The scintillation detector described above should provide a counter which is more efficient than a boron trifluoride counter for neutrons with energies lying between 100 and 100,000 eV. A practicable thickness of boron-10 (2–2½ cm.) is effectively 'black' to neutrons of up to 10,000 eV., so that the efficiency should remain constant up to this energy. It will best be employed with sources relatively free from γ-rays, such as the pulsed time-of-flight spectrometer suggested by Cockcroft[2]. Work on these applications is proceeding.

We wish to thank Mr. G. N. Harding for supplying us with an anthracene crystal.

J. C. Duckworth
A. W. Merrison
A. Whittaker

Atomic Energy Research Establishment,
Harwell.
Aug. 22.

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Photo-electric Disintegration of the Deuteron at 6·13 and 17·6 MeV.

We have measured the cross-section of the deuteron for disintegration by γ-rays of effective energy 6·13 and 17·6 MeV. The results are:

$$\sigma_{6\cdot13} = (21\cdot5 \pm 1\cdot2) \times 10^{-28} \text{ cm.}^2$$
$$\sigma_{17\cdot6} = (\ 8\cdot5 \pm 1\cdot2) \times 10^{-28} \text{ cm.}^2$$

(both these uncertainties are probable errors). The γ-rays were obtained, in the first case, by bombarding thick targets of calcium fluoride with protons of energy 890 keV., and, in the second, by bombarding thick targets of lithium hydroxide with protons of energy 500 keV. The disintegrations were produced in an ionization chamber of volume 475 c.c. containing deuterium at a pressure of 38 atmospheres; the pulses from the resulting protons were analysed by a ninety-nine channel kick sorter. An identical chamber, filled with ordinary hydrogen, was used for estimating the various background effects. The γ-ray flux from the fluorine target was measured by counting the α-particles emitted prior to the de-excitation of the residual oxygen-16 nucleus. The flux of higher energy γ-rays was measured with a thick-walled graphite ionization chamber : confidence in the computations was increased by the agreement (within 3 per cent) between the values of the 6·13-MeV. γ-ray flux deduced by this method, and by the more certain α-particle counting method. In the reduction of the results, allowance has been made for the small and known inhomogeneity of the γ-rays in both cases. The energies of the γ-rays have been adopted from the work of Walker and McDaniel[1], and their relative intensities from this work and from that of Burcham and Freeman[2]. For the purpose of these slight corrections, the form of the dependence of cross-section on γ-ray energy given by the 'old' theory[3] has been assumed.

Previous measurements of this cross-section have been reported, at the lower energy by van Allen and Smith[4], who find $(11{\cdot}6 \pm 1{\cdot}5) \times 10^{-28}$ cm.^{2}, and at the higher energy by Wäffler and Younis[5], who find $(8 \pm 3) \times 10^{-28}$ cm.^{2}.

The theory of the photo-disintegration of the deuteron is not sufficiently definite at the moment to enable a comparison with these experiments to be made in a short note.

We would like to thank Dr. W. B. Lewis for arranging for the analysis of the deuterium at the laboratories of the National Research Council of Canada at Chalk River.

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Dec. 14.

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Sub-Crystals in Aluminium Observed with Polarized Light

IN the course of some work on crystal-grain phenomena in creep specimens of aluminium alloys, we have used the polarized light technique for microscopic examination described by Hone and Pearson[1], and found clear evidence of the original crystals breaking down into sub-crystals under certain conditions of deformation. In this technique, any grain contrast seen is due to differential orientation in the aluminium, at least with unstrained metal.

Before creep tests were undertaken, material in course of preparation was examined, and distinct differences between hot- and cold-rolled metal were found. The microstructure of hot-rolled material is shown in Fig. 1 ; the original large grains still exist as regions between which there are large orientation differences ; but they have broken down into much smaller sub-crystals between which there are usually relatively small contrast differences, suggesting relatively small orientation differences. The original grains have acquired an irregular outline which corresponds to the sub-crystal structure. The structure of cold-rolled material is shown in Fig. 2 and has neither an irregular grain outline nor a clear sub-crystal structure. If the patchiness inside the large grains truly indicates orientation differences in this strained material, the change in orientation between patches occurs gradually over a considerable distance, and not sharply as in the sub-crystal structure of Fig. 1.

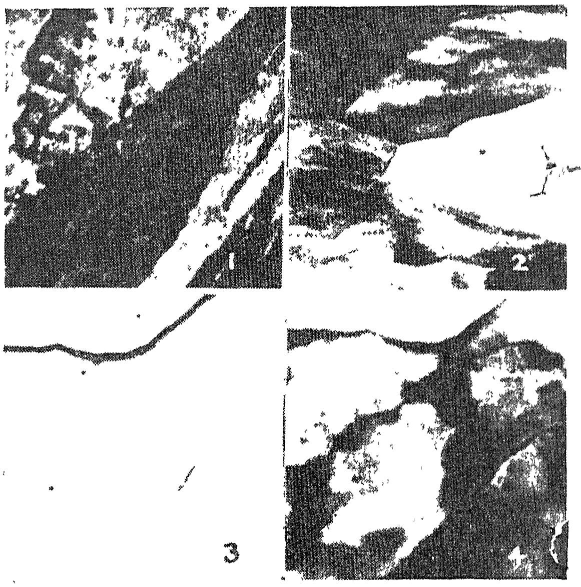

Fig. 1. Hot-rolled ; polarized light
Fig. 2. Cold-rolled ; polarized light
Fig. 3. Creep specimen ; normal lighting
Fig. 4. Same area as Fig. 3 ; polarized light
All photographs × 200

At this juncture the paper by Wilms and Wood[2] was received describing the observation of a 'cellular' appearance on the polished surface of a creep test specimen during test. This structure was not observed in specimens deformed at room temperature, so it seemed very probable that the 'cells' and the sub-crystals referred to above were identical.

It was therefore with added interest that examination of the creep specimens was commenced. A transverse section of a specimen strained 20 per cent in 20 hr. at 200° C. is shown under normal illumination in Fig. 3 and under polarized light in Fig. 4. The sub-crystal structure is actually well developed, although practically invisible under normal illumination.

These results thus support the observations of Wilms and Wood, and show that the sub-crystal structure develops not only at the surface but also throughout the body of the material during suitable hot deformation. The sub-crystal structure may be similar to that which has been observed in certain rather special samples of cold-worked and annealed aluminium[3].

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Influence of the Bonding Electrons on the Scattering of X-Rays by Carbon

DURING the course of an investigation of the scattering of X-rays by various carbons (incompletely graphitized materials containing graphite-like layer-planes but no three-dimensional crystalline order, and showing, therefore, only (00*l*) crystalline reflexions and (*hk*) two-dimensional bands) it was observed that the intensity of the (10) band was always anomalously high. The phenomenon was found to be of perfectly general occurrence for a wide variety of carbons. For microcrystalline graphite a similar anomaly was observed in the intensity of the (100) line. Moreover, examination of intensity curves published by other authors[1] confirms the generality of the phenomenon.

Details of these results, which were obtained with a high degree of accuracy, are being published in *Acta Crystallographica*. A vacuum camera and strictly monochromatic radiation were used. Measurements were made for values of $\sin\theta/\lambda$ up to 1·1, and, after correction for absorption and geometric factors, the intensity of scattering at large angles was used for obtaining the complete scattering curve in absolute (electron) units. Using the equations developed by Warren[2], which give both the form and the absolute intensity of the (*hk*) bands in terms of a single variable, the layer diameter, it was found that the observed intensity of the (10) band was twice the theoretical intensity. For the (11) and all higher-order bands the observed and calculated intensities were in good agreement.

This anomaly is clearly not one which can be explained by the influence of thermal agitation. If the observed 50 per cent reduction in the ratio of the intensity of the (11) band to that of the (10) were due to thermal agitation, then the intensity of the higher-order bands would be reduced in even greater proportion, whereas, in fact, all higher-order bands show, within experimental error, the theoretical intensities. Moreover, as has been mentioned above, measurements of *absolute* intensities show that it is the (10) band which is enhanced, and not the other bands which are reduced in intensity.

These results indicate that the influence of thermal agitation on the intensity of the (*hk*) bands is negligible. This is perhaps not surprising. The (*hk*) bands are due exclusively to the structure within a single graphite-like layer, and the thermal vibrations in the plane of such a layer must be considerably less even than in diamond. Indeed, Nelson and Riley[3] have shown that graphite has virtually no thermal expansion in directions lying in the plane of the layers.

It seems that the anomalously high intensity of the (10) band (or of the (100) line) must be attributed to the configuration of the valency electrons in graphite or in carbons containing incipient graphitic layers. The atomic scattering factors used for calculating intensities were those of James and Brindley[4]. These apply to a spherical, non-bonded atom, and are therefore particularly liable to error for light atoms in which the proportion of electrons involved in bond-formation is high. The error is greatest at low angles where the contribution of the outer, bonding electrons to the total scattering is large. In carbon, the only (10) band (or (100) reflexion) which occurs in the angular range in which the *L*-electrons make an appreciable contribution to the atomic scattering factor is the (10) (or (100)), and it is here that an anomaly may be expected.

The three sp^2 electrons in a graphitic carbon atom are directed in a single plane, the layer-plane, and are concentrated around the centres of the C—C bond rather than at the atomic nuclei[5]. The following qualitative calculation shows that this configuration may be expected to lead to a (10) band or (100) reflexion of intensity greater than that calculated for a spherical atom.

For a spherical atom, the electron density in a spherical shell of radius r and thickness dr is uniform and equal to $\rho(r)$. The contribution of this shell to the amplitude of the (100) line or to that of the (10) band in the position corresponding to the (100) line is given, for a unit cell containing two atoms in a single graphitic layer, by

$$dF'_{10} = 4\pi r^2\rho(r)dr\frac{\sin(2\pi r/d_{100})}{2\pi r/d_{100}} = dm\frac{\sin(2\pi r/d_{100})}{2\pi r/d_{100}}$$

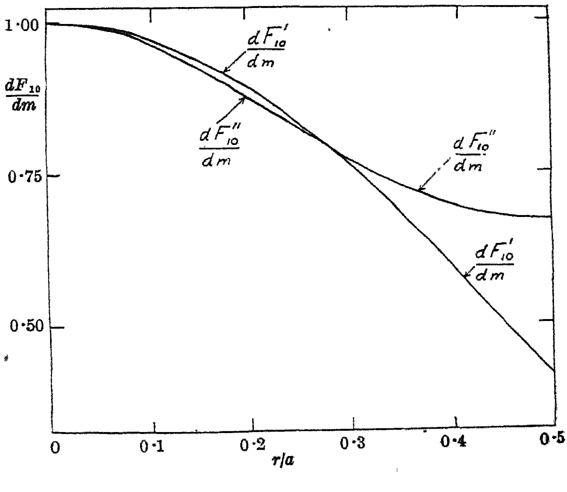
in electron units, where $dm = 4\pi r^2\rho(r)dr$ and d_{100} is the spacing for the (100) reflexion in graphite.

If it be supposed, as a very rough approximation for the sp^2 electrons, that the electron content of each such shell is equally distributed between three points still at distance r from the atomic nucleus, but situated on the C—C bonds in the graphitic layer, then the contribution to the structure factor for a unit cell containing two atoms becomes

$$dF''_{10} = \frac{2dm}{3}\cos\left\{2\pi\left(\frac{1}{3}+\frac{r}{d_{100}}\right)\right\} + \frac{4dm}{3}\cos\left\{2\pi\left(\frac{1}{3}+\frac{r}{2d_{100}}\right)\right\}.$$

The variation of $\frac{dF'_{10}}{dm}$ and $\frac{dF''_{10}}{dm}$ with r/a, where $a = \frac{2}{3}d_{100}$ is the C—C bond-length, is shown in the accompanying graph. It is seen that for small values of r/a, dF'_{10} and dF''_{10} differ little; but for values of r approaching half the bond-length, dF''_{10} is considerably greater than dF'_{10}. Since the greatest electron density for the sp^2 electrons lies midway between two carbon atoms, it is to be expected that the integrated amplitude for the (100) reflexion (or the (10) band) will be greater than that calculated using the atomic scattering factor of James and Brindley.

These results are not in disagreement with measurements by Lipson and Stokes[6] of intensities on a powder photograph of graphite. These authors plot



their results in the form of $I_{\text{obs.}}/I_{\text{calc.}}$ on a logarithmic scale against $\sin^2\theta$, and show that they are grouped around a straight line the slope of which is considered to represent the temperature factor. The experimental points, however, fall clearly into two groups. In the low-angle part, the ratio decreases approximately according to the logarithmic relationship indicated. But for $\sin^2\theta > 0{\cdot}4$ the ratio is approximately constant. In view of what has been said above, the following interpretation seems more reasonable. The temperature factor is negligible. In the high-angle region only K-electrons contribute to the scattering, and the observed and calculated intensities are in constant ratio. In the low-angle part, the ratio $I_{\text{obs.}}/I_{\text{calc}}$ for the series $(10l)$ decreases with increasing l, corresponding to a decreasing contribution of the L-electrons with increasing angle of scattering.

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X-Ray Irradiation of Cellulose Acetate

As is well known, the physical properties of many plastics are modified when they are exposed to light or ultra-violet radiation; the most important change is a decrease in tensile strength[1], and an increased electrical conductivity.

In the course of work on these phenomena, samples of undyed, unoiled cellulose acetate yarn were suspended in front of a 0·001 in. aluminium window of a 'Raymax' copper-target X-ray tube, operated at 50 kVp., 30 m.amp., and were exposed to the radiation for periods up to 190 hours.

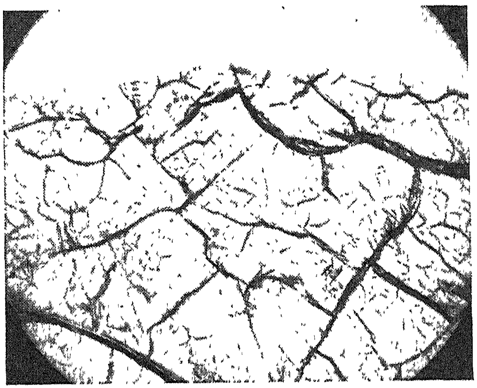
The variation of the breaking load (tensile strength) with exposure was found to be given by:

$$\ln\frac{S_0}{S_T} = kT,$$

where S_0 is the original strength, S_T the strength after an exposure of T hours and k is a constant. The tensile strength, measured at 65 per cent relative humidity and 20° C., decreased to less than 50 per cent of the original strength after 120 hours exposure. Similar results were obtained with cellulose acetate yarn containing 3 per cent titanium dioxide delustrant. All breakages occurred within the limits of the irradiated patch, and under a microscope showed a very brittle fracture. Strengths measured at intervals over a further period of 100 hr. after removal from the beam were found to be constant.

X-ray diffraction photographs, of a clear sample of cellulose acetate of relatively high crystallinity, measuring roughly 5 cm. × 4 cm. × 0·15 cm. (cut from a small block obtained by very slow evaporation of an acetone solution), were taken after irradiating the sample by placing it over a circular aperture of 0·5 cm. radius in a lead plate and exposing it to the above radiation for time intervals up to 40 hr. Such photographs showed a progressive diffuseness of the pattern from a series of relatively well-defined rings in the original sample (before exposure treatment) to two very blurred broad rings, similar to the type of pattern obtained from less crystalline samples produced by rapid evaporation of an acetone solution.

At the end of a 40-hr. exposure, the irradiated patch showed a marked yellowish-brown coloration and a mosaic of minute fissures, some of which penetrated the sample, but the majority of which were restricted to the surface of the sample facing the tube, indicating the effect to be due to a long-wave component of the X-ray spectrum. No differential staining was observed with 'Shirlastain'; but on washing out the stain a very large number of new and finer fissures could be seen under the microscope. Both types of fissures are shown in the accompanying photomicrograph, which also shows the clear line of demarcation between the exposed and lead-shielded regions.



After an exposure of 20 hr., the slightly discoloured patch in a sample of unplasticized cellulose acetate film was rapidly delustred in a 1·4 per cent solution of phenol in water, while the shielded regions remained clear even on standing in the solution for 24 hr. In terms of A. R. Urquhart and J. B. Marsden's[2] work on phenol delustring, this effect suggests that X-ray irradiation decreases the crystallinity of the sample, confirming the results of the diffraction patterns discussed above.

When a strip of clear unplasticized cellulose acetate film was dipped into molten paraffin wax so as to be covered by a layer of wax, and then irradiated for 24 hr., bubbles of gas were observed in the wax; these bubbles forced the wax away from the film over the irradiated patch. No gas bubbles were observed on irradiating a control sample of wax for 72 hr., and the gas was therefore presumably given off by the cellulose acetate on irradiation by X-rays.

Certain dyestuffs were found to be bleached when irradiated by the above X-radiation in exposures as short as 9 hr.

The results described seem to indicate that chemical and structural changes may take place in certain substances during long exposures required for X-ray diffraction patterns, and may influence the interpretation of the diagrams.

I am indebted to Mr. S. Simmens for taking the photomicrograph, and to the directors of Lansil, Ltd., for permission to publish this note.

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[1] Egerton, G. S., *J. Soc. Dyers and Col.*, **64**, 336 (1948).

[2] Urquhart, A. R., and Marsden, J. B., Shirley Inst. Mem., **18**, 121 (1942), and *J. Text. Inst.*, **7**, *T* 105 (1942).

Influence of Firing Temperatures on the Preparation of Barium Titanate

In the course of work on the preparation of barium titanate ceramics, it was found necessary to determine the extent of the reaction of the starting materials at various temperatures and the crystal structure of the final product.

The barium titanate was prepared by two different methods. In one case, titanium oxide (TiO_2) was added to molten $Ba(OH)_2.8H_2O$ at about 100° C.; the other involved mixing and pressing barium carbonate and titanium oxide together. Samples prepared by both methods were heated to various temperatures and then examined by X-ray diffraction methods. The extent of reaction in the formation of barium titanate is indicated in Tables 1 and 2.

Table 1

Samples made from $Ba(OH)_2.8H_2O + TiO_2$

Temp. of firing (in ° C.)	Percentage of $BaTiO_3$ present
400	90
500	50–60
600	,,
700	,,
800	,,
900	,,
1,000	,,

Table 2

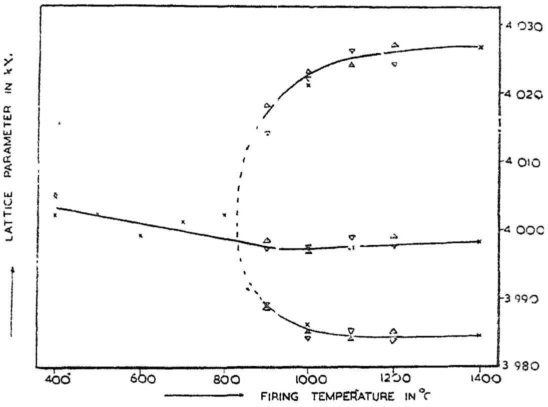
Samples made from $BaCO_3 + TiO_2$

Temp. of firing (in ° C.)	Percentage of $BaTiO_3$ present
800	60
900	80
1,000	90
1,100	95
1,200	100
1,300	100
1,400	100

It will readily be seen in Table 1 that, whereas at 400° C. the reaction was at least 90 per cent complete, this was not so when the material was fired at higher temperatures. Barium hydroxide, $Ba(OH)_2$, melts at a temperature somewhat less than 400° C., and this may be the cause of the increased reactivity. Hedvall and his co-workers have studied intensively the effects in reacting systems when one member undergoes a physical change, and it seems that the effect here observed is another example of such an occurrence.

It will be noted that in the first set of experiments, for samples heated to temperatures higher than 400° C., there was no increase in the degree of reaction with temperature up to the limit of 1,000° C., and the total quantity which reacted was actually less at 1,000° C. than at 400° C. Presumably, the material did not exist long in the vicinity of the melting point of barium hydroxide when fired to higher temperatures, and therefore was less influenced by the favourable conditions experienced there. For the samples of barium carbonate and titanium oxide heated over the same temperature-range, there was an increase in the reaction which may be explained by the fact that the barium carbonate is more easily decomposed than the hydroxide. It required a firing of at least 1,200° C. for 1 hour in oxygen for complete interaction of the components, and even then the structure of the resulting compound was not identical with that fired at 1,400° C.

The structure of these materials is most interesting. It is recognized that owing to incomplete reaction in most instances, and the uncertainty in determining the exact quantity of the components which did not react, the resulting compounds may depart from the stoichiometric proportions to some extent. Nevertheless, some general conclusions can be drawn which are of importance. The barium titanate has, for samples heated below 800° C., a cubic lattice of the perovskite type. Above 800° C. it is tetragonal, the axial ratio, lattice parameters, and volume depending on the temperature of firing.



Dependence of lattice parameter on firing temperature

The accompanying graph indicates the results obtained. The volume of the unit cell decreased with temperature until the tetragonal distortion set in. No anomaly in the constants was observable at 400° C. nor was one to be expected in spite of the increase in the extent of the reaction at this temperature. Points were not plotted below this temperature owing to the low accuracy of measurement due to poor crystallization. The lines in the X-ray diffraction pattern are diffuse, the broadening depending on the firing temperature.

The lower density of the product in the cubic region may be due to imperfections in the lattice due to cation and anion sites being randomly vacant. These would decrease the binding energy and also act as a barrier to co-operative phenomena. Now it is well recognized that the electrostrictive properties of barium titanate and the formation of electric domains must involve a co-operative interaction of one unit cell with its neighbour, leading to a polarization in the same sense over the whole of a domain. If imperfections are introduced which hinder this mechanism, the structure may have locally a tetragonal symmetry which may not extend for more than a few unit cells; long-range order is absent, however, and the unique axis is directed in three mutually perpendicular directions in the crystal, the statistical effect of which is to impart a cubic symmetry to the whole. The broadening of the X-ray lines will qualitatively fit in with this view, for as the lines become sharper, the density increases until the tetragonal distortion takes place. A sample having a cubic structure was cooled to liquid air temperature to see if the Curie point had been depressed by the preparative conditions; but no change in symmetry was found.

We wish to thank Mr. J. A. M. van Moll and the directors of Philips Electrical, Ltd., for permission to publish this note.

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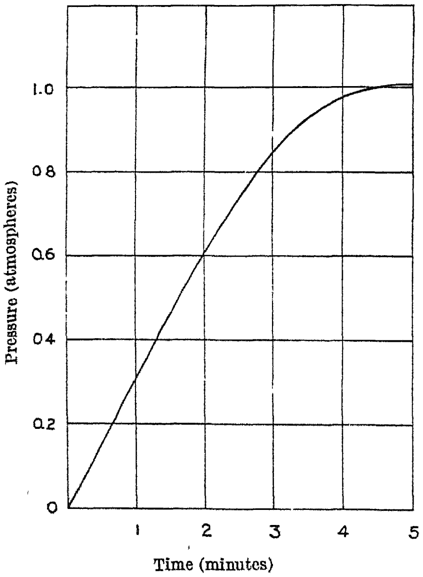
Measurement of the Ratio of the Principal Specific Heats of a Gas

THE constant, γ, relating the principal specific heats of a gas may be determined directly by a number of classical methods involving adiabatic expansions, the most reliable of which are the determination of the velocity of sound in the gas (Kundt's method) and the observation of adiabatic variations in gas pressure and temperature (Clément and Desormes, Lummer and Pringsheim's methods respectively).

A new direct method, utilizing another kind of adiabatic change, has been developed to measure γ for air. The method can be extended to other gases and involves the observation, on a U-manometer containing mercury, of the growth of pressure with time (see graph) in an initially evacuated chamber into which atmospheric air is effusing through an orifice.



The linear portion of the curve represents the initial stage of the effusion, in which the gas expands laterally after passage through the orifice. The non-linear portion of the curve represents the final stage of the effusion, in which the gas issues in the form of a non-expanding jet, the pressure at the throat of which equals the pressure within the chamber. In accordance with classical hydrodynamics, the pressure, p, at which lateral expansion ceases for a perfect gas is given by the relationship: $p = \left(\frac{2}{\gamma+1}\right)^{(\gamma/\gamma-1)}P$, where P is the pressure outside the chamber. The continuity of the pressure–time relationship prevents the accurate determination of p from the diagram. If, however, advantage is taken of the audible introduction of turbulence at the transition point, as has been observed when suitable apertures are used, it is possible to measure p and hence γ.

The effect has been investigated for circular apertures only, and has been found to be critical when these have finite lengths of the order of their diameters. To minimize errors in the reading of p on the rising mercury column, it has been found necessary to use tubes of diameter not greater than 1 mm. in conjunction with a chamber of volume 50 litres. With the present apparatus, γ for air can be estimated to within one per cent of the accepted value.

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A New Naturally Occurring Amino-Acid

INVESTIGATION of the amino-acids of *C. diphtheriæ* by paper chromatography has shown that an acid hydrolysate of the water-insoluble portion of the micro-organism contains an unknown ninhydrin-reacting substance in addition to seventeen known amino-acids[1]. This substance, the position of which on the phenol-collidine chromatogram is shown in Fig. 1, has now been isolated and identified as α-ε-diaminopimelic acid,

$$COOH.CH(NH_2).(CH_2)_3CH(NH_2).COOH.$$

The following method was used for separating the amino-acid from other constituents of the acid hydrolysate. Neutralized hydrolysate was run through a column of acid-treated alumina[2]; the unknown amino-acid, although neutral, was retained on the column with the acidic amino-acids if a sufficient excess of alumina was used, whereas the rest of the amino-acids, with the exception of traces of glycine, serine, threonine and alanine, passed through. Elution with dilute ammonia was followed by electrodialysis of the concentrated eluate. The neutral fraction, completely freed from acidic constituents, yielded on concentration a white crystalline material which proved to be the unknown amino-acid. Each stage in the purification was checked by paper chromatography.

The final product (Fig. 2), after crystallization twice from water and once from aqueous alcohol, gave the following analytical figures: C, 44·3; H, 7·45; N, 14·8; α-amino N (Van Slyke ninhydrin-CO_2), 14·4; diaminopimelic acid, $C_7H_{14}N_2O_4$, requires C, 44·2; H, 7·42; N, 14·8 per cent). The crystals were only moderately soluble in cold water and aqueous alcohol, soluble in dilute acids and alkalis, and insoluble in all other solvents. The substance did not melt or decompose up to 305° C.

α-ε-Diaminopimelic acid was synthesized by Sörensen in 1908[3], and the properties as described

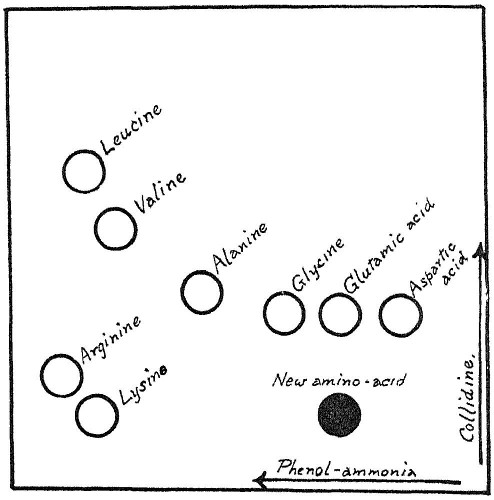

Fig. 1. Position of new amino-acid on paper chromatogram

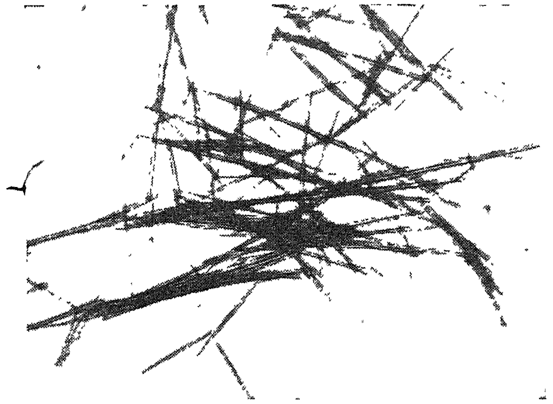

Fig. 2. Crystals of new amino-acid from *C. diphtheriæ* (× 380)

by him corresponded closely with those of the compound isolated here. Sörensen prepared a dibenzoyl derivative, a specimen of which I have been able to examine through the kindness of Prof. Linderstrøm-Lang. The solubilities of synthetic dibenzoyl-diaminopimelic acid were similar to those of the benzoyl derivative prepared from the new amino-acid, and both crude derivatives melted over the range 181–199° when observed on the micro-stage melting-point apparatus. Repeated crystallization of the dibenzoyl derivative of the naturally occurring amino-acid, first from 25 per cent ethanol and then from ethylacetate light petroleum mixture, produced a compound crystallizing as fine needles of melting point 193° (found: C, 63·7; H, 5·88; N, 6·89; dibenzoyl-diaminopimelic acid, $C_{21}H_{22}N_2O_6$, requires C, 63·3; H, 5·57; N, 7·04 per cent). After similar recrystallizations of the synthetic compound, the resulting crystals did not appear homogeneous under the microscope and melted less sharply at 195–197°; mixed melting point with natural derivative, 193–195°. The crystalline forms of the synthetic and natural dibenzoyl derivatives were not identical. α-ε-Diaminopimelic acid has two optically active carbon atoms, and it is evident that mixtures of stereo-isomers could be influencing the solubility, melting point and crystalline form of the benzoyl derivatives of both the natural and the synthetic amino-acids. The optical activity of the naturally occurring amino-acid has not yet been measured, as the possibility of some racemization during preparation was not excluded.

Final proof of structure was obtained by treatment of the amino-acid with nitrosyl bromide, followed by catalytic reduction of the dibromo derivative; the product was identified as pimelic acid by the fact that it did not depress the melting point of an authentic specimen of pimelic acid. α-ε-Diaminopimelic acid, obtained by hydrolysis of the synthetic dibenzoyl derivative, was indistinguishable from the natural amino-acid on phenol-collidine paper chromatograms.

The new amino-acid occurs mainly in the water-insoluble portion of the diphtheria bacillus, although a small amount is also found, with the other commonly occurring amino-acids, in ethanolic extracts of the cells[1]. It is probable, therefore, that diaminopimelic acid is a constituent of the bacterial protein; its concentration is of the same order as that of the other common amino-acids.

Diaminopimelic acid may well prove to be widely distributed among bacteria, since a substance with similar properties has already been shown by other workers[4,5] to be present in certain products of bacterial origin.

I am indebted to Mr. J. Smiles, of the National Institute for Medical Research, for the photograph of the crystalline material.

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Zirconium Esters

THE interesting results recorded recently by Speer[1], and by Cullinane and Chard[2], on the conditions for the preparation of titanium *ortho*-esters prompt us to mention our experience in preparing *ortho*-esters of zirconium. The literature contains little information on this subject. Meerwein and Bersin[3] have recorded that zirconium ethoxide can be prepared by the following reactions:

$$(1)\quad ZrCl_4 + 5\,NaOEt + EtOH = NaH[Zr(OEt)_6] + 4\,NaCl.$$

$$(2)\quad NaH[Zr(OEt)_6] + HCl = Zr(OEt)_4 + NaCl + 2\,EtOH.$$

We find, however, that a number of alkyl *ortho*-esters of zirconium can be obtained directly from the reaction of zirconium tetrachloride, a primary alcohol and anhydrous ammonia. With secondary alcohols this procedure is not satisfactory. The products are hydrolysed esters. The pure esters can be obtained by ester interchange between the ethyl *ortho*-ester and a secondary alcohol. For example:

$$(3)\quad Zr(OEt)_4 + 4\,iso\text{-}C_3H_7OH = Zr(OC_3H_7\text{-}iso)_4 + 4\,EtOH.$$

In the case of *iso*propyl alcohol, the ester separates as a crystalline solid with the composition $Zr(OC_3H_7\text{-}iso)_4$, *iso* C_3H_7OH. The direct action of zirconium tetrachloride and *iso*propyl alcohol yields a hydrolysed chloro-*iso*propoxy zirconium compound. The hydrolysis arises from the water produced by the reaction (4*b*) of the alcohol with hydrogen chloride liberated in the initial reaction (4*a*).

$$(4a)\quad ZrCl_4 + iso\text{-}C_3H_7OH = ZrCl_3(OC_3H_7\text{-}iso) + HCl.$$

$$(4b)\quad HCl + iso\text{-}C_3H_7OH = iso\text{-}C_3H_7Cl + H_2O.$$

The reaction of type 4*b*, involving a secondary or tertiary alcohol and hydrogen chloride, is well known (cf. the reaction of titanium tetrachloride and tertiary butyl alcohol mentioned by Cullinane and Chard[2]).

We have isolated from the reaction of zirconium tetrachloride and ethyl alcohol a new crystalline solid, $ZrCl_3(OEt),EtOH$. This underlines the distinctive difference between the reactions of silicon tetrachloride and alcohols, and the corresponding reactions involving the tetrachlorides of titanium and zirconium. Titanium and zirconium tetrachlorides yield chloro-alkoxy derivatives, whereas the well-known silicon *ortho*-esters are the products from the reactions with silicon tetrachloride. The *ortho*-esters of zirconium, as one would expect, are much less volatile than those of either titanium or silicon. For example, $Zr(OEt)_4$, crystallized from benzene, sublimes at 120° C. at 10^{-4} mm. pressure. The *iso*-propyl ester, with its addendum of *iso*-propyl alcohol, has a melting point of 138–141° C. and the $Zr(OC_3H_7\text{-}iso)_4$ distils at 160° C. at 0·1 mm. pressure.

Details of this work will be published elsewhere.

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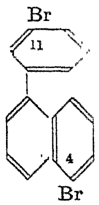
Orientation of Disubstituted Fluoranthene Derivatives

Although fluoranthene is readily attacked by bromine, etc., none of the disubstituted products has been rigidly orientated. Tobler *et al.*[1] obtained a fluoranthene disulphonic acid, which on fusion with alkali followed by oxidation gave a coloured 'chinhydronartigen' compound, and they rightly pointed out that a quinoid product would mean that sulphonation had occurred at the 4 : 11-positions. Their evidence, however, is not conclusive and experimental details are lacking.



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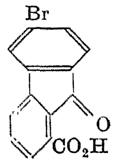

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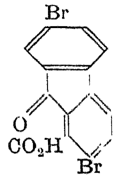

III

The bromination of fluoranthene yields a substance which we have now shown to be 4 : 11-dibromofluoranthene (I). Oxidation with chromic acid and acetic acid gives a monobromo compound, presumably 6-bromo-1-carboxyfluorenone (II), and 2 : 7-dibromo-1-carboxyfluorenone (III), the constitution of which follows from its decarboxylation products. When heated with quinoline and copper bronze, it yields 2-bromofluorenone, and it is undoubtedly the bromine atom adjacent to the carboxyl group which is removed, since under the same conditions 2-bromo- and 2 : 7-dibromo-fluorenone are unchanged while 2-bromo-1-carboxyfluorenone and 7-bromo-1-carboxyfluorenone yield fluorenone and 2-bromofluorenone respectively. More conclusive proof of the structure of III comes from decarboxylation at 250° with mercuric oxide[2] to give 2 : 7-dibromofluorenone. The constitution of the original dibromofluoranthene is thus unambiguously established, and consequently other disubstituted fluoranthenes can be orientated. For example, the fluoranthene dicarboxylic acid obtained by the action of oxalyl chloride on fluoranthene[3] is the 4 : 11-compound, should it be identical with the di-acid prepared from 4 : 11-dibromofluoranthene by standard methods.

Details of these and related experiments will be published elsewhere.

Thanks are expressed to the Department of Scientific and Industrial Research and to the Anglo-Iranian Oil Co. for grants.

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Alanine and Taurine Formation from Injected Cysteine in the Rat

The pathways for cysteine metabolism have been studied intensively, and a great deal is known about the many reactions which lead to the formation of sulphate. Most of the studies on cysteine have been mainly concerned with the fate of sulphur; but relatively few experimental results exist concerning the fate of the carbon chain. Recently, Fromageot and Chatagner[1] have furnished proof of the existence of an enzyme, desulphinicase, in liver of rabbits. This enzyme is capable of liberating sulphurous acid from L-cysteine sulphinic acid. They considered the latter compound to be the most important intermediate in the conversion of organic sulphur to inorganic sulphur; they assumed that the splitting of sulphurous acid from L-cysteine sulphuric acid gave alanine as an intermediate. The formation of alanine from cysteine sulphinic acid has been demonstrated in rabbit liver extracts[2].

Using rats of the Sprague-Dawley strain, it was possible to demonstrate in this laboratory that intravenously administered cysteine causes a significant increase in the concentration of alanine in the liver. The analyses of tissues for alanine were carried out by means of quantitative paper chromatography[3]. In this manner, it was possible to measure simultaneously other amino-acids present in tissues. Taurine, which unfortunately is not well separated from glycine by phenol in one-dimensional chromatograms, was also measured.

Concentration of alanine and taurine in rat liver after cysteine injection*

	Alanine (mgm. per 100 gm. fresh tissue)			Taurine (mgm. per 100 gm. fresh tissue)		
	Time after injection 30 min.	60 min.	120 min.	Time after injection 30 min.	60 min.	120 min.
Controls	41 ± 1·6	44 ± 3·4	43 ± 2·3	58 ± 2·9	60 ± 5·3	47 ± 5·3
Cysteine injected	114 ± 1·9	97 ± 4·8	71 ± 2·9	143 ± 3·2	99 ± 3·4	99 ± 2·9

* Arithmetic mean of values from four animals plus or minus the standard errors corrected for small numbers.

The results shown in the accompanying table were obtained from groups of four animals. The concentration of the alanine and taurine–glycine fractions in the cysteine-injected groups was higher than that found in the saline-injected controls. The differences were statistically significant. This finding warrants the assumption that taurine and alanine were formed in the cysteine-injected animals.

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Virulence-enhancing Factor of Hog Gastric Mucin

FROM the time of the original discovery of the virulence-enhancing power for bacteria of hog gastric mucin by Miller[1] and, independently, Nungester[2], the effect has been used extensively in the production of experimental infections of animals, as, for example, in chemotherapeutic and in serum testing (for review, see ref. 3). A large number of different species of bacteria show enhanced virulence when injected intraperitoneally together with the mucin, and the effect is often striking—a reduction of 10^4–10^5 in L.D.50 is frequent. Furthermore, the effect is not confined to hog gastric mucin: other mucins have been reported active. This suggests that the mucins coating epithelial surfaces may aid pathogenic bacteria in their initial attack; such a possibility makes the investigation of mucins for a chemical entity producing the effect an interesting problem.

Several groups have published work along this line. Anderson and Oag[4] using a chemical method, and Gould and King[5] by differential centrifugation, reported the separation of an impure active material from commercial hog gastric mucin. In both cases the fraction was sparingly soluble in water, and of protein rather than carbohydrate nature. King[6] later described a method of extraction with formamide, and stated that his former method was difficult to repeat. Morgan and King[7] prepared blood group A substance from commercial mucin. The preparations retained the virulence-enhancing effect of the original mucin. Electrophoresis of these preparations showed them to contain 90 per cent of a single component and 10 per cent of an ill-defined contaminant.

In commencing work on chemical extraction, the first essential was to develop a statistically adequate method of biological assay. *B. typhosum* (strain *Ty*$_2$) was selected as the test organism and the mouse as the experimental animal, the test dose being given by the intraperitoneal route. Mucin fractions were compared with a 'standard' mucin preparation, a constant number of organisms being injected in the presence of falling concentrations of the test material. Batches of at least twenty mice were used for any concentration. Using probit analysis, this method of assay would detect regularly rather less than a twofold difference in virulence-enhancing power.

Crude blood-group substance (A and H) was prepared as described before from fresh hog stomach linings[8], instead of from the dried commercial mucin of unknown history. The crude blood-group substance possessed virulence-enhancing activity. By prolonged dialysis at *p*H 4·2 in the refrigerator two fractions were separated. (*a*) A larger soluble fraction (50–60 per cent) which is precipitated by four volumes of alcohol. It contains the blood-group substance (A and H) and, dissolved in water, forms a viscous solution; this has negligible virulence-enhancing activity. (*b*) A smaller insoluble fraction (10–15 per cent) which has virulence-enhancing activity. More of this material was prepared directly from fresh linings, and further purified by extracting with water at *p*H 6 and the use of strong sodium salicylate solutions. This still heterogeneous material was practically insoluble in water at *p*H 7, formed a comparatively non-viscous suspension, and contained 14·5 per cent nitrogen (Dumas). In aqueous suspension alone, different batches had activities from six to nine times greater than the crude blood-group substance. However, when suspended in a completely inactive 3·5 per cent solution of fraction (*a*), which imparts a marked viscosity to the suspension, this activity was increased three-fold. An exactly similar result, namely, a three-fold increase of activity, was produced by suspending the active material in tragacanth mucilage (0·17 per cent w/v, inactive alone) to give a suspension with the same viscosity as the above (Ostwald viscometer, 37°).

Hence the virulence-enhancing power of hog gastric mucin is not due to one factor only, as reported or tacitly assumed in previous work, but to a combination of: (1) the virulence-enhancing factor which is active alone, but far more so in the presence of (2), which is an inert factor or factors which, in view of the experiment with tragacanth, may well act by providing a viscous medium for the virulence-enhancing factor. There is no doubt that blood-group substance (A and H) is responsible for at least part of, if not all, this viscosity.

Full details of this work, which is being continued, will be published elsewhere. Acknowledgment is made to the Chief Scientist, Ministry of Supply, for permission to publish this communication.

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Allergy in Two Stages

THE phenomena very briefly outlined in this communication are the results of a planned series of investigations undertaken to clarify certain observations the significance of which was not at first very evident. Only certain (human) subjects are sensitive to injections of the materials referred to, and it is with regard to such 'sensitives' that the following account applies.

The two preparations used throughout the investigations were selected, (1) from the middle member (later called *B*) of a series of five enzymic protein hydrolysates, representing different stages of a digest ranging from high molecular solutions to relatively low, and (2) from another similarly prepared (later called *A*), this latter representing a relatively low molecular solution, further processed for the removal of the larger molecules. These hydrolysates contained 5 per cent of the original protein and 1 per cent procaine, and were prepared by Messrs. Bengers, Ltd.

Injections were given at three- and four-day intervals (that is, intervals between stages), and a short-size 20 Record needle ensured that they were in part intramuscular and deep subcutaneous. Site of re-injection was always within a few centimetres of the previous site. The sites selected for injection were (1) left upper and outer gluteal quadrant, (2) right upper and outer gluteal quadrant, (3) left deltoid, (4) right deltoid, (5) left fascia lata, (6) right fascia lata.

Reactions following injection, when they did occur, appeared after a ten-minute interval, and the patient was under observation for an average period of two hours.

Stage	Injection	Site	Reaction	Sites
1	*A* 5 c.c	1	None perceptible	
2	*A* 5 c.c	2	None perceptible	
3	*A* 5 c.c. *B* 0·4 c.c	1	Erythema induration and urticaria ('triple response')	1
4	*B* 0 25 c.c.	2	Triple response	1, 2
5	*B* 2 c.c.	4	None perceptible	
6	*A* 1 c.c.	2	Triple response	1, 2
7	*A* 0·5 c.c.	4	Triple response	1, 2, 4
8	*A* 3 c c. *B* 3 c.c	3 5	None perceptible	
9	*A* 0·25 c.c.	5	Triple response	1, 2, 4, 5
10	*B* 0·25 c.c	3	Triple response	1, 2, 3, 4, 5
11	*B* 3 c.c.	6	None perceptible	
12	*A* 0·25 c c	2	Triple response	1, 2, 3, 4, 5

The following conclusions may be drawn:

(*a*) *A* injected at a free site fails to provoke reaction. *B* injected at a free site is also without reaction. *A* and *B* may be injected simultaneously at separate free sites without provoking reaction.

(*b*) *A* and *B* injected mixed or consecutively at one site even at one-twelfth of the usual dose provokes intense local reaction at that site, and secondarily at all other *AB* sites, but never at an *A* or a *B* site.

(*c*) If *A* is injected at a *B* site or *vice versa*, even though the interval which separates the injections is as long as three months, triple response follows at that site and secondarily at all other *AB* sites. In such an instance *A* and *B* are, as it were, masquerading as allergens.

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Effect of Streptomycin Preparations on Gut Responses to Contractor Substances

When streptomycin is administered by mouth, only a small proportion is absorbed, and very high concentrations of the drug can be obtained in the stools, 2–9 mgm. per gm. having been recorded without toxic symptoms[1,2]. It seemed of interest, therefore, to determine whether such concentrations could have any effect on the motility of the gut other than by virtue of the bacteriostatic action.

Fresh guinea pig ileum preparations were set up in a standard gut bath of 3·5 ml. capacity, and the streptomycin added either by pipette or by means of a separate alternative reservoir in a system based on that described by Schild[3]. No effect was noted when low concentrations of the drug were employed; but when sufficient streptomycin was added to the bath to produce concentrations of the order of $4 \cdot 8 \times 10^{-3} M$, the normal 'pendulum' movements of the gut were diminished.

To investigate this effect further, known concentrations of acetyl-choline were used to stimulate the gut, and streptomycin was tested as an antagonist. When streptomycin was added to the gut bath to produce a concentration of $1 \times 10^{-3} M$, the contraction caused by acetyl-choline added 30 sec. later was reduced to that produced by 0·7 times that quantity of acetyl-choline in the absence of streptomycin. A similar effect was observed when the streptomycin was added only a few seconds before the acetyl-choline, as well as when both were added together as a pre-mixed solution.

To determine the degree of specificity of this action, a comparison was made substituting histamine acid phosphate for acetyl-choline. In this case, the antagonistic action was greater. The addition to the bath of 0·1 ml. of a streptomycin solution containing 100 mgm./ml., producing a concentration of $4 \cdot 8 \times 10^{-3} M$, completely inhibited the response of the gut to 1 microgram of histamine acid phosphate in 1 ml. of solution added 30 sec. later. If 2 micrograms of histamine acid phosphate were added, it was necessary to double the concentration of streptomycin in order again to produce complete elimination of response. The same direct correlation of streptomycin concentration to histamine acid phosphate dose held true over a tested range of 0·1 to 3 micrograms of the phosphate. As with acetyl-choline, the degree of antagonism was the same when the streptomycin was added to the bath only a few seconds before the histamine acid phosphate and when they were added together as a pre-mixed solution.

To assess more accurately the quantitative relationship between concentration of streptomycin and amount of histamine acid phosphate inhibited, streptomycin was dissolved in Tyrode's solution and set up in the alternative reservoir system. At a concentration of $1 \times 10^{-3} M$ streptomycin in Tyrode's solution, the contraction produced by histamine acid phosphate approximately equalled that produced by half the amount of the drug in the absence of streptomycin. Even when the gut was exposed to this concentration of streptomycin for as long as 15 min., there was no evidence of increased inhibition of response to successive doses of histamine acid phosphate.

The addition of streptomycin during the contraction caused by histamine acid phosphate, acetyl-choline or peptone produced immediate partial relaxation, and successive small additions of streptomycin resulted in a step-wise relaxation.

The sulphate, calcium chloride complex and hydrochloride salts of streptomycin of several different makes were tested with essentially the same results. Sterile aqueous solutions of streptomycin at concentrations of 50 mgm. and 100 mgm./ml. kept at 0–4° C. for periods up to a year showed no diminution of inhibitory action on gut response to the contractor substances tested.

Preliminary experiments on the chloralosed cat have shown no inhibition of the blood-pressure response to intravenous histamine acid phosphate or acetyl-choline by streptomycin administered intravenously in doses up to 30 mgm. per kilo of body-weight, either when the streptomycin was administered up to 15 min. before the depressor substance, or when they were administered simultaneously.

It is difficult to exclude the possibility that the results obtained using the gut preparations may be due, not to the streptomycin, but to an impurity.

If such an impurity were comparable in activity to some of the more recently discovered anti-histamine substances, a concentration of less than 1 part in a million in the streptomycin could produce these effects. However, it seems unlikely that an impurity active in very low concentrations would be present in such constant amounts in all the streptomycin preparations tested. Furthermore, it has been shown[4] that less highly purified preparations of streptomycin have a definite histamine-like action.

We are indebted to Dr. W. H. Hughes and Dr. H. C. Stewart for their advice and criticism, and to Dr. P. A. Nasmyth for his assistance with the cat experiments.

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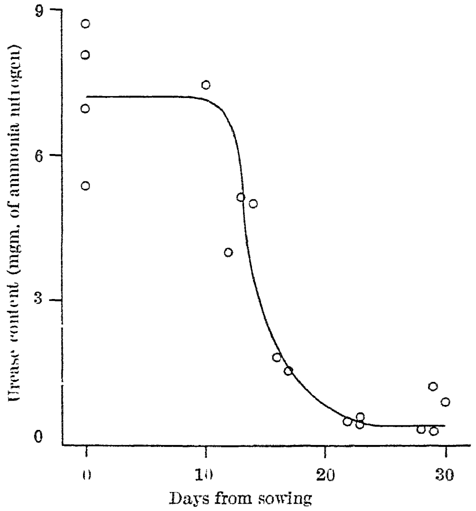
Function of Urease in *Citrullus* Seeds

IT is customary to assume that an enzyme fulfils the function *in vivo* that it exhibits *in vitro*, however surprising the conclusions to which this leads; yet it is frequently overlooked that, were its true function unknown, hæmoglobin might similarly be credited only with its powers of acting as a peroxidase, or absorbing carbon monoxide, neither of which would form a useful basis for a study of the physiology of blood. The extremely high concentration of urease found in a number of seeds is an interesting example of this type of problem; it can, for example, be readily calculated from the results below that the cotyledons of the seed of *Citrullus* (the water-melon) contain sufficient urease to decompose more than their own weight of urea every hour. Moreover, the technique used has been such that this result is almost certainly too low. An extensive literature on the occurrence of urease exists, virtually all of it directed to the production of pure or concentrated urease preparations for kinetic studies or urea determinations; the function of the urease in the seed receives in general no more than a puzzled mention.

I suggest that the urease is present simply as a reserve protein, and that its urea-hydrolysing capacities are, so far as the seed is concerned, completely irrelevant. If this is true, some light might be expected to be thrown on the problem by investigating the fate of the urease when the seed germinates.

Citrullus seeds ('mixed') were sown in soil and the seedlings harvested individually at irregular intervals. No selection was carried out, and germination was distinctly erratic, the seedlings emerging between about the tenth and fifteenth days after sowing. It was ascertained by qualitative methods that all but a trace of the urease present was in the cotyledons, so further investigation was confined to these. The cotyledons of a given seedling were ground up in water and a known quantity of this extract digested with 3 per cent urea in $M/6$ phosphate buffer at pH 7 for 15 min. at 30° C., the reaction being stopped with saturated potassium carbonate solution and the ammonia determined by aeration into $N/100$ sulphuric acid. The accompanying figure, in which each point represents in arbitrary units the total amount of urease in a single seedling, shows the results obtained. Despite the great variability, the general pattern is clear: on germination, there is a sharp fall in urease content to about one-fifteenth of the amount present in the seed. Since urease is not destroyed in the course of the reaction it promotes, this is incompatible with its enzymatic function; but it is exactly what would be expected if urease, in common with the other reserve material of the seed, were being drawn upon as a reserve protein during the early stages of germination.



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Appearance of *Elminius modestus* Darwin in South Africa

GREAT attention has been directed recently to the occurrence of the barnacle *Elminius modestus* along the south coast of Britain, where it is supposed it has been carried on the hulls of ships from Australia[2]. Prior to 1945, this southern hemisphere barnacle had never been recorded in the northern hemisphere; but in that year Bishop[2] and Crisp and Chipperfield[3] noted it in great numbers at Chichester and Fambridge, Essex. Since then it has spread so rapidly along the south coast of Britain that it is now a potential enemy of the periwinkle and oyster industries[1,5].

Although *Elminius modestus* is reputedly a southern hemisphere species, it appears to be restricted to Australia and New Zealand[4], and up to the present had not been recorded in South Africa. Recently, however (July 1949), on experimental plates kept by Dr. N. A. H. Millard and myself in Cape Town Docks, a single individual appeared on a plate which had been submerged at a depth of 2 ft. for three months. This specimen measured 3 mm. carino-rostrally, and, assuming the growth-rate is comparable to a growth of 6 mm. in forty days recorded by Bishop in England, this specimen would not be as old as three months.

If *Elminius modestus* becomes more prolific in South Africa and spreads, as it did along the south coast of Britain and even over to Holland[1] within three years of its first being recorded, it is likely that competition with *Balanus algicola* is more keen than with *Balanus balanoides* and other British species. The reason for this is that *B. algicola* appears, like *E. modestus*, to breed practically all the year round[6], and it is the most prolific species of barnacle in the Cape, settling to a density of 130 per sq. in. on experimental plates.

The incidence of *E. modestus* in the Cape Town Docks suggests that it has been introduced on the hull of a ship. If it becomes established, its spread will be noted with great interest.

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A Species of *Stauromatonema* in Mysore

COLLECTIONS of algæ made in the Cauvery River, Mysore, included a species of *Stauromatonema*, a member of the Capsosiraceæ. The alga was associated with *Nostochopsis lobatus* (Wood) Geitler[1], on the submerged rocks and small pebbles. The colonies appear as small brownish-green incrustations usually distributed on rock surfaces that are exposed directly to water currents. This is in contrast to the conditions in which *Nostochopsis lobatus*[2] is found.

The thalli of *Stauromatonema* formed tough flat incrustations on the rock surface, so that it is very difficult to get good mounts showing all parts of the thallus. The thallus is composed of a basal prostrate system, having a cellular sheet (Fig. 2), formed by contorted filaments which show irregular cell divisions. From these, erect filaments which are parallel to one another and compactly grouped to form a concrescent cushion are produced. The filaments are simple or show lateral pseudodichotomous branching, the latter being upcurved and disposed in a parallel manner. The cells of the filament are rectangular, being broader than long, measuring 5–9 μ in diameter with a mean of 7 μ. The mucilaginous sheath is firm and persistent. The cells of the filament show intercellular connexions (Fig. 1). A few heterocysts have been noticed which are colourless, with refractive cell contents, and resemble those described by Frémy (Geitler)[1]. In several cases the planococci (Fig. 1), similar to those reported and illustrated by Frémy, have been observed.

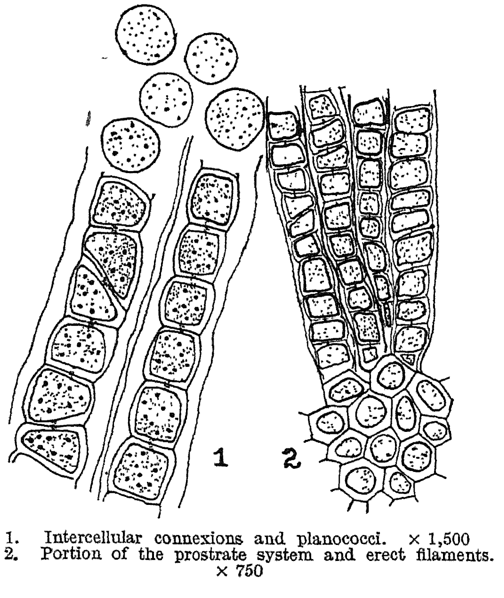


Fig. 1. Intercellular connexions and planococci. × 1,500
Fig. 2. Portion of the prostrate system and erect filaments. × 750

The present record of the alga in Mysore is of interest since the previous report of it has been only from tropical Africa by Frémy. The abundance of the alga in several places indicates that it may prove to be a very common alga of fast-flowing streams in Mysore. The alga under study resembles *Stauromatonema viride* described by Frémy (Geitler)[1] in several respects, and is tentatively referred to that species.

We wish to express our thanks to Dr. M. J. Thirumalachar for help in making field observations.

H. C. GOVINDU
K. M. SAFEEULLA

20 Fifth Main Road,
Malleswaram,
Bangalore.
July 14.

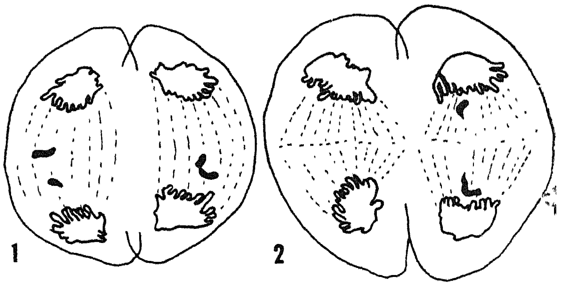
[1] Geitler, L., Cyanophyceæ, Rabenhorst's Kryptogamenflora von Deutschland, Österreich und der Schweiz, 467 (1932).

[2] Govindu, H. C., Razi, B. A., and Safeeulla, K. M., *Curr. Sci.*, **18**, 258 (1949).

Two Types of Misdivision of the Centromere

MISDIVISION of the daughter-univalents at second meiotic anatelophases occurs frequently in the pollen mother cells of heterozygous speltoid wheat of the B-series ($2n = 6x - 1 = 41$), as has been shown by Sánchez-Monge and MacKey[1].

Using microtome slides in order to retain the intracellular arrangement of the chromosomes, I have studied the position of the misdividing univalent as well as the position of the two telocentric fragments resulting from misdivision. My observations seem to show that misdivision can be achieved in two different ways.



In some cases the position of the telocentrics and their diverging proximal ends (Fig. 1) indicates that the misdivision is due to an attraction of the spindle poles acting in opposite directions on the two transversal components of the centromere or half-spindle spherules[2,3]. Thus this type of misdivision is a consequence of an error, either of direction of attraction or of insertion of the chromosomal spindle fibres on the half-spindle spherules. This form of misdivision could be correctly called 'attraction-misdivision' or shortly '*a*-misdivision'.

In other cases, the stretched and converged proximal ends of the telocentrics (Fig. 2) suggest a pushing away of the two arms of the daughter-univalents, produced either by the so-called stem-body or by the forces assumed by Östergren to act within the spindle tactoid[4]. This pushing away of the chromosome arms produces at first the separation of their distal ends, afterwards the stretching and finally the misdivision of the centromere. This mechanism may act too late or not strongly enough, and then the misdivision is completed by the formation of the cell wall[5]. This second type of misdivision can be called 'push-misdivision' or '*p*-misdivision'.

E. SÁNCHEZ-MONGE

Estación Experimental de Aula Dei,
Apartado 202,
Zaragoza, Spain.
Aug. 19.

[1] Sánchez-Monge, E., and MacKey, J., *Hereditas*, **34**, 321 (1948).
[2] Östergren, G., *Botaniska Notiser*, 176 (1947).
[3] Lima-de-Faria, A., *Hereditas*, **35**, 77 (1949).
[4] Östergren, G., *Botaniska Notiser*, 467 (1945).
[5] Nishiyama, I., *Mem. Coll. Agric., Kyoto Imp. Univ.*, 32 (1934).

A New Species of Root Eelworm Attacking Carrots

IN the summer of 1944, cysts of a root eelworm were found on carrots growing on a smallholding at Chatteris in the Isle of Ely. Afterwards, infestations were noted on carrots in several other fields in the same area, some of which were alleged to have grown carrots for twenty years in succession. Where the infestation was heavy, the crop was poor and patchy. Plants lifted from the poor patches were stunted and carried an abundance of lateral roots; but this development of lateral roots was less marked than in sugar beet heavily attacked by the beet eelworm (*Heterodera schachtii*).

So far as I am aware, the only previous record in Great Britain of carrots being attacked by a cyst-forming species of *Heterodera* is that of Triffit[1]. The species appears to be new and undescribed, and a summary of its more important features is given below.

Carrot root eelworm (*Heterodera carotæ*, n.sp.)

Cysts	
Shape	Lemon
Size, length	Max. 0·68 mm.; min. 0·21 mm.
breadth	Max. 0·53 mm.; min. 0·15 mm.
Length/breadth	2·3 to 1·35
Regression coefficients	
Length/breadth	0·6584 ± 0·057
Breadth/length	0·7084 ± 0·059
Colour	White changing to brown on death of female. No intermediate yellow stage, as in potato root eelworm
Gelatinous egg sac	Present and large, in full-grown specimens equal in size to the cyst and containing many eggs
Larvæ	
Length	454 μ
Male cysts	
Size on rupturing cortex	0·33 mm. × 0·09 mm. approximately
Males	
Size, length	1·19 mm.
breadth	31·4 μ
Stylet	28·8 μ
Copulatory spicule	Bi-dentate as in *H. schachtii*
Host range	Only cultivated and wild carrot attacked out of 106 plants tested, including the hosts of other common species of *Heterodera*

H. carotæ falls into the group of *Heterodera* species in which the male has copulatory spicules with bi-dentate tips, as in *H. schachtii* and *H. cruciferæ*. On this character alone it can be distinguished from the other species. From *H. schachtii* it differs considerably in size and shape, and in the possession of a large egg sac into which many eggs are extruded. From *H. cruciferæ* it can be distinguished by its smaller size, by differences in its length–breadth relationships and in host-range. In addition, the larval length of *H. cruciferæ* is given as 418 μ by Franklin[2], whereas that of *H. carotæ* is 454 μ.

An account of *H. carotæ* and of observations on other species of *Heterodera* is being prepared for publication elsewhere.

F. G. W. JONES

School of Agriculture,
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Aug. 30.

[1] Triffit, M. J., *J. Helminth.*, **13**, 3 (1935).
[2] Franklin, M. T., *J. Helminth.*, **21**, 2 and 3 (1945).

Blinking and Sleep

As normal blinking is involuntary, it might be expected that blinking would proceed at its normal or at a somewhat reduced rate during sleep, as with breathing and the heart-beat. This is not so, however, though little seems to have been published on the subject, especially on the quantitative side. Whereas many of the muscles are relaxed during sleep, "the muscular tone of the muscles which keep the eyes closed is undoubtedly increased". Duke-Elder[1] states that the occurrence of bilateral blinking movements "may be used as a test for the simulation of sleep".

My interest in the subject has prompted me to utilize the relatively few opportunities open to a physicist to examine the problem on a number of children and on several adults. In all cases so far examined, it has been found that in sleep the eyelids are quiescent, and show no signs whatsoever of blinking movements.

During a recent long train journey, opportunity was afforded of examining the problem in its quantitative aspects, the subjects being a young man and his wife, both of whom fell asleep several times during the course of the journey. Their interblink periods were determined when awake (eyes open), when resting with closed eyes, and observations were continued for up to 15 min. after they had fallen asleep. In each case the conditions of the individual tests were clearly as nearly identical as was possible, and check determinations could be made; the subjects were quite unaware that they were under observation. The results are incorporated in the accompanying table. It did not prove practicable to obtain an accurate determination of the interblink period of the male resting with closed eyes, owing to the rapid onset of sleep in his case; but accuracy was possible with the female, who rested with closed eyes occasionally for a period greater than ten minutes.

Condition of subject	Interblink period	
	Male	Female
Awake (eyes open)	2·0 sec.	1·6 sec.
Resting (eyes closed)	*c.* 1·8 sec.	1·6 sec.
Asleep	∞	∞

Interesting conclusions follow from these observations. The interblink periods of each subject when awake and when in the resting condition were sensibly identical, whereas in sleep bilateral lid movements ceased entirely. There was no indication in either case of any slowing down of the blink-rate with the approach of sleep; indeed, on one occasion the female subject ceased blinking immediately after three lid movements each separated in time by less than one second. It appears that the time taken for the transition from consciousness to unconsciousness under natural conditions is not more than one or two seconds. There was no clear indication that the degree of closure of the eyes during sleep was greater than when the eyes were closed voluntarily during resting periods.

ROBERT W. LAWSON

Department of Physics,
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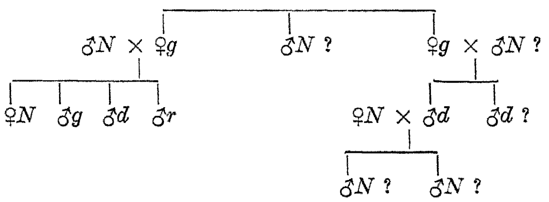
Sept. 1.

[1] "Text-Book of Ophthalmology", 1, 644 (Henry Kimpton, London, W.C.1, 1942).

Three Pedigrees for Colour Blindness

THREE pedigrees have been found which are of interest in relation to the two-locus theory of the inheritance of red-green blindness formulated by Waaler[1] and Franceschetti[2], and summarized by Gates[3]. The present hypothesis suggests two series of alleles with near loci on the X-chromosome, N, r, r', p and N', g, d', d, in which N and N' stand for the normal genes, r for red anomaly, r' for red anomaly with darkened red[4], p for protanopia, g for green anomaly, d' for deviant or anomalous deuteranopia[5], and d for ordinary deuteranopia. The orders of dominance are believed to be as shown above, N and N' being the most dominant. The two-locus theory is supported by the observation that certain women carrying genes from both series are of normal phenotype[1,6,7], and the discovery all over the world of fewer women defectives[3] than would be expected on the single-locus theory by the calculation given by Ford[8].

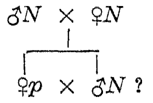


Pedigree I

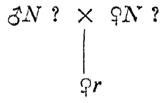
In Pedigree I there are two green anomalous sisters whose brother (deceased) was believed to be normal. These sisters married men who were believed to have normal colour vision because they were employed on the railway. One, who was tested by me, was normal; the other (deceased) had not been suspected of any defect. The first sister had four children: a normal daughter, one deuteranope son, one green and one red anomalous, all tested by me. The other sister had two sons, one a deuteranope, exactly like his cousin in every detail of colour vision, married to a normal woman and having two sons believed normal but too young to test. The other (deceased) was believed to have been a deuteranope.

In order to explain this pedigree, we may assume that the two sisters were both double heterozygotes of genotype rg/Nd, using the system of notation suggested by Ford[8], in which the oblique line separates genes on different chromosomes. Their deuteranope sons would be $Nd/$—, while the green and red anomalous sons would be produced, by crossing-over, the green anomalous being $Ng/$— and the red anomalous $rd/$—. The genotype of the red anomalous son is a conjecture based on the assumption that the gene which is more dominant in its own series would be more effective in this combination than the gene of lower dominance in the parallel series. Another conjecture would be that the genes r and d together would produce only that quality in the phenotype which they could share. The red anomalous colour match in the Rayleigh equation is a possible match for a deuteranope, whereas all other possible deuteranope matches would be impossible for red anomalous vision. The latter conjecture would apply only when the red end of the spectrum is not darkened in red anomalous vision, as in the present case.

The normal daughter might be of genotype rg/NN', a double heterozygote in which the two defective genes in different loci have equal and opposite effects, and probably cancel each other out. De Vries has suggested that this combination is of normal phenotype[6].



Pedigree II



Pedigree III

Pedigrees II and III illustrate the possibility that a man of normal phenotype may have a colour-blind or anomalous daughter and a normal son. In Pedigree II we may assume that the father was of genotype $pd/$—, and of normal phenotype, which has been suggested for this combination when it occurs in a woman in the form pd/NN'. If the mother was a normal heterozygote of genotype pN'/NN', the daughter would be pN'/pd, a protanope homozygote and a deuteranope heterozygote together. The son, if normal as believed, would be $NN'/$—, or, if not normal, then a protanope, $pN'/$—.

In Pedigree III the father, believed to be normal, might be of genotype $rg/$—, and of normal phenotype because these genes produce equal and opposite effects, while the mother could be the normal red anomalous heterozygote, rN'/NN'. The daughter would be rN'/rg, a red anomalous homozygote and green anomalous heterozygote at the same time, and be of red anomalous phenotype, as found.

R. W. PICKFORD

Psychology Department,
University,
Glasgow, W.2.
Aug. 26.

[1] Waaler, G. H. M., *Z. für. ind. Abs. und Ver.*, **45**, 279 (1927).
[2] Franceschetti, A., *Schweiz. Med. Wochensch.*, **9**, 1273 (1928).
[3] Gates, R. R., "Human Genetics", chapter 6 (1946).
[4] Pickford, R. W., *J. Psychol.*, **27**, 153 (1949).
[5] de Vries, Hl., *Physica*, **14**, 367 (1948).
[6] de Vries, Hl., *Genetica*, **24**, 199 (1948).
[7] Gray, R. C., *Nature*, **153**, 657 (1944).
[8] Ford, E. B., "Genetics for Medical Students" (2nd edit., 1946).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, January 16

UNIVERSITY OF LONDON (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 4.30 p.m.—Prof. R. A. Morton: "Biochemistry of Carotenoids". (Further Lectures on January 23 and 30.)*

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 8.15 p.m.—Canon Jules Detry: "Forbidden Tibet".

Tuesday, January 17

SOCIETY OF CHEMICAL INDUSTRY, AGRICULTURE GROUP (in the Chemistry Department, Royal College of Science, Imperial Institute Road, London, S.W.7), at 2.30 p.m.—Sir Harold Tempany: "Some Agricultural Problems of the Colonial Empire".

UNIVERSITY OF LONDON (at the London School of Economics and Political Science, Houghton Street, Aldwych, London, W.C.2), at 5 p.m.—Prof. M. G. Kendall: "The Statistical Approach" (Inaugural Lecture).*

INSTITUTE OF PHYSICS, ELECTRONICS GROUP (at 47 Belgrave Square, London, S.W.1), at 5.30 p.m.—Dr. D. K. C. MacDonald: "Fluctuations Noise and Recent Developments".

SOCIETY OF CHEMICAL INDUSTRY, PLASTICS AND POLYMER GROUP (at the Royal Society of Tropical Medicine, Manson House, 26 Portland Place, London, W.1), at 6.30 p.m.—Dr. T. H. Morton: "Textile Applications of Synthetic Resins" (Members of the Textile Institute and the Society of Dyers and Colourists are invited.)

SHEFFIELD METALLURGICAL ASSOCIATION (at 198 West Street, Sheffield), at 7 p.m.—Annual General Meeting.

INSTITUTION OF ELECTRICAL ENGINEERS, CAMBRIDGE RADIO GROUP (at the Cavendish Laboratory, Cambridge), at 8.15 p.m.—Mr. K. F. Sander: "The Application of Differential Analysers with Electrolytic Tanks for Tracing Electron Trajectories".

Wednesday, January 18

INSTITUTE OF PHYSICS (at 47 Belgrave Square, London, S.W.1), at 5.30 p.m.—Mr. E. W. Golding: "Windmills as Electrical Power Generators".

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY, SOCIAL PHILOSOPHY SECTION (at the Portico Library, Mosley Street, Manchester), at 5.30 p.m.—Prof. W. J. M. Mackenzie: "Unacknowledgeable Means".

PHYSICAL SOCIETY, LOW TEMPERATURE GROUP (in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 5.30 p.m.—"The Piping, Storage and Transport of Liquefied Gases".

ROYAL MICROSCOPICAL SOCIETY (in the Hastings Hall, B.M.A. House, Tavistock Square, London, W.C.1), at 5.30 p.m.—Annual General Meeting; at 6 p.m.—Dr. R. J. Ludford: "Chemically Induced Derangements of Cell Division" (Presidential Address).

BRITISH INSTITUTION OF RADIO ENGINEERS, NORTH-EASTERN SECTION (at the Neville Hall, Westgate Road, Newcastle-upon-Tyne), at 6 p.m.—Mr. G. H. Hickling: "Activities and Equipment of an Industrial Electronic Laboratory".

INSTITUTION OF ELECTRICAL ENGINEERS (at the Central Hall, Westminster, London, S.W.1), at 6.30 p.m.—Dr. R. A. Smith: "Radar" (Faraday Lecture). (To be repeated at 6.30 p.m. at The Guildhall, Southampton, on Friday, January 20.)

MANCHESTER METALLURGICAL SOCIETY (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Dr. J. Ward: "Photo Elasticity".

ROYAL INSTITUTE OF CHEMISTRY, LONDON AND SOUTH-EASTERN COUNTIES SECTION (joint meeting with the LONDON SECTION OF THE SOCIETY OF CHEMICAL INDUSTRY, at the Royal Society of Medicine, 1 Wimpole Street, London, W.1), at 6.30 p.m.—Mr. A. K. Soper: "The Physical Chemistry of the Gelatin-Water System".

ROYAL STATISTICAL SOCIETY, NORTH-EASTERN GROUP of the INDUSTRIAL APPLICATIONS SECTION (at the Chemical Industries Club, 18 Lovain Place, Newcastle-upon-Tyne), at 6.30 p.m.—Mr. D. G. Beech: "Graphs and Correlation". (To be repeated at 6.30 p.m. at the Chamber of Commerce, 95 New Street, Birmingham, on Wednesday, March 22.)

Thursday, January 19

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Discussion on "The Evolution of Arthropodan Locomotory Mechanisms" (to be opened by Dr. S. M. Manton, F.R.S., and Dr. C. F. A. Pantin, F.R.S.).

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. D. Meksyn: "Integration of the Laminar Boundary Layer Equations".

SOCIETY OF ANTIQUARIES OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Miss K. M. Kenyon: "The Excavation of Sutton Walls Camp, Herefordshire".

ROYAL AERONAUTICAL SOCIETY (joint meeting with the ACOUSTICS GROUP of the PHYSICAL SOCIETY, at 4 Hamilton Place, London, W.1), at 5.30 p.m.—Short Lectures on "Acoustical Aspects of Recent Aerodynamic Research".

CHEMICAL SOCIETY, HULL SECTION (joint meeting with the UNIVERSITY COLLEGE SCIENTIFIC SOCIETY, in the Science Lecture Theatre, University College, Hull), at 6 p.m.—Prof. E. E. Turner, F.R.S.: "Modern Trends in Stereochemistry".

BRITISH INSTITUTION OF RADIO ENGINEERS (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6.30 p.m.—Mr. A. J. Tyrrell: "The Performance and Stability of Permanent Magnets".

CHEMICAL SOCIETY, MANCHESTER SECTION (joint meeting with the ROYAL INSTITUTE OF CHEMISTRY and the SOCIETY OF CHEMICAL INDUSTRY, in the Chemistry Department, The University, Manchester), at 6.30 p.m.—Prof. C. A. Coulson: "Localised and Non-localised Bonds".

CHEMICAL SOCIETY (at the Royal Institution, Albemarle Street, London, W.1), at 7.15 p.m.—Prof. M. G. Evans, F.R.S.: "Studies on Electron-transfer Reactions" (Tilden Lecture).

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at Manson House, 26 Portland Place, London, W.1), at 7.30 p.m.—Prof. N. H. Swellengrebel (Amsterdam): "The Malaria Epidemic of 1943–46 in North Holland".

Thursday, January 19—Friday, January 20

BRITISH INSTITUTE OF RADIOLOGY (joint meetings with the RADIOLOGICAL SECTION of the ROYAL SOCIETY OF MEDICINE, at 32 Welbeck Street, London, W.1), at 8.15 p.m. each day.

Thursday, January 19

"Use of Radioactive Isotopes—Some Diagnostic Techniques."

Friday, January 20

"The Therapeutic Uses of Radio-Isotopes."

Friday, January 20

ASSOCIATION OF APPLIED BIOLOGISTS (in the Mining Lecture Theatre, Imperial College of Science and Technology, Prince Consort Road, London, S.W.7), at 2.15 p.m.—"The Locust Problem" (Dr. B. P. Uvarov: "Principles, Policy and Organization", Dr. D. L. Gunn: "Research and Development").

CHEMICAL SOCIETY, BIRMINGHAM SECTION (joint meeting with the UNIVERSITY CHEMICAL SOCIETY, in the Main Chemistry Lecture Theatre, The University, Edgbaston, Birmingham), at 4.30 p.m.—Dr. J. K. N. Jones: "The Separation and Determination of the Sugars and their Derivatives".

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Mr. James Tobin: "A Statistical Demand Function for Food in the U.S.A.".

MANCHESTER STATISTICAL SOCIETY (joint meeting of the STATISTICAL METHODS GROUP and the INDUSTRIAL GROUP, at the Albert Hall, Peter Street, Manchester), at 6 p.m.—Mr. G. F. Todd: "Statistical Aspects of Productivity Analysis".

SOCIETY OF CHEMICAL INDUSTRY (joint meeting of the FOOD GROUP and the FINE CHEMICALS GROUP, at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Prof. A. C. Frazer: "Fine Chemicals and the Food Industry".

SOCIETY OF DYERS AND COLOURISTS, MANCHESTER SECTION (at the Gas Department Showrooms, Town Hall Extension, Manchester), at 6.30 p.m.—Mr. R. Thornton: "Some Critical Factors affecting the Development of Brentogens in Textile Printing".

INSTITUTE OF PHYSICS, MANCHESTER AND DISTRICT BRANCH (in the New Physics Theatre, The University, Manchester), at 7 p.m.—Mr. J. A. Hall: "Temperature Measurement".

CHEMICAL SOCIETY, NORTHERN IRELAND SECTION (joint meeting with the ROYAL INSTITUTE OF CHEMISTRY and the SOCIETY OF CHEMICAL INDUSTRY, in the Royal Academical Institution, Belfast), at 7.30 p.m.—Mr. J. McG. Jackson: "Chemical Education".

ROYAL SOCIETY OF MEDICINE, RADIOLOGY SECTION (at 1 Wimpole Street, London, W.1), at 8.15 p.m.—Discussion on "The Therapeutic Uses of Radio-isotopes".

Saturday, January 21

BIOCHEMICAL SOCIETY (at the British Postgraduate Medical School, Ducane Road, W.12), at 11 a.m.—Scientific Papers.

BRITISH MYCOLOGICAL SOCIETY (in the Department of Biology, Chelsea Polytechnic, Manresa Road, London, S.W.3), at 11 a.m.—Scientific Papers.

BRITISH PSYCHOLOGICAL SOCIETY (in the Hastings Hall, Tavistock House, Tavistock Square, London, W.C.1), at 2.30 p.m.—Dr. D. W. McElwain: "A Review of Psychology in Australia".

LONDON COUNTY COUNCIL (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Sir Richard Paget: "The Origin and Nature of Human Speech".*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN CHEMISTRY at the County Technical College, Wednesbury—The Director of Education (Dept. F.E.), County Education Offices, Stafford (January 21).

LECTURER (Grade II) IN THE DEPARTMENT OF GEOLOGY, to teach applied geophysics—The Secretary, The University, Birmingham 3 (January 21).

SENIOR SCIENTIFIC OFFICER or SCIENTIFIC OFFICER (with good honours degree or equivalent in physics) at the Atomic Energy Research Establishment, Harwell—The Technical and Scientific Register (K) York House, Kingsway, London, W.C.2, quoting A.320/49A (January 23).

LECTURER IN NEUROLOGY in the Department of Neurology, Manchester Royal Infirmary—The Registrar, The University, Manchester 13 (January 31).

Professor and a **Lecturer in Mathematical Physics**, a **Reader** and a **Senior Lecturer in Mathematics**, a **Senior Lecturer** and two **Lecturers in Physics**, a **Senior Lecturer in Inorganic and Physical Chemistry**, a **Reader in Botany**, a **Senior Lecturer in Paleontology**, a **Senior Lecturer** and a **Lecturer in Physiology**, a **Senior Lecturer in Anatomy**, a **Senior Lecturer in Pathology**, a **Senior Lecturer in Mechanical Engineering** (preferably in Fluid Mechanics), a **Senior Lecturer in Civil Engineering**. a **Senior Lecturer in Mining and Metallurgy**, a **Lecturer in Electrical Engineering**, a **Reader** and a **Lecturer in Psychology**, and a **Professor of Philosophy**, at the University of Adelaide, South Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (January 31).

Research Officer, Building Research Section, Melbourne (Ref. No. 2417), a **Research Officer, Physical Chemistry Section**, Division of Industrial Chemistry, Fishermen's Bend (Ref No 2556), and a **Research Officer, Minerals Utilization Section**, Division of Industrial Chemistry, Melbourne (Ref. No. 2159), in the Commonwealth Scientific and Industrial Research Organization—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (February 4)

Senior Scientific Officers for theoretical work on problems in photoconductivity and theory of solids, **Scientific** or **Senior Scientific Officer** with post-graduate training in statistics for the planning and statistical evaluation of experimental work and trials, and **Scientific Officers** for (*a*) theoretical and experimental work on external ballistics and research on general theory of weapons, and (*b*) mathematical work on radar problems, at Ministry of Supply Research and Development Establishments in South England and South Midlands—The Technical and Scientific Register (K), York House, Kingsway, London, W.C 2, quoting A.326/49A (February 6).

Senior Scientific Officer (Ref No. A.179/49A) at the Ministry of Supply Tropical Testing Establishment, Nigeria, to lead group of physicists and engineers studying effects of tropical conditions on service materials and equipment, and an **Experimental Officer** or **Assistant Experimental Officer** (Ref. No G.253/49A) with at least Higher School Certificate qualifications in a biological subject or equivalent and some experience in fields of mycology and/or entomology—The Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (February 10).

Principal of the L.C C. Norwood Technical College, Knight's Hill, West Norwood, London, S.E.27—The Education Officer (T.1), County Hall, London, S.E.1 (February 11)

Reader, Senior Lecturer, or **Lecturer, in Animal Husbandry**, at Makerere College, Uganda—The Secretary, Inter-University Council, 1 Gordon Square, London, W.C.1 (February 15).

Research Assistant in Dyeing—The Registrar, The University, Leeds 2 (February 15).

Anthropologists (4, one experienced field-worker and three junior field-workers) at the East African Institute of Social Research, Makerere College, Uganda—The Secretary, Inter-University Council, 1 Gordon Square, London, W.C.1 (February 18).

Lecturer in Anatomy at Makerere College, Uganda—The Secretary, Inter-University Council, 1 Gordon Square, London, W.C.1 (February 18).

Lecturer in Moral Philosophy—The Secretary, The University, Aberdeen (February 18).

Lecturer in Agricultural Zoology—The Secretary, The University, Aberdeen (February 28).

Graduates (men and women, of any University) for three Post-graduate Research Fellowships in special groups of subjects in the Faculties of Arts and Science—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1 (March 1).

Scholarships in the School of Cosmic Physics: one in the Astronomical Section at Dunsink Observatory, Co. Dublin, and one in the Cosmic Ray Section, Merrion Square, Dublin—The Registrar, Dublin Institute for Advanced Studies, 64–65 Merrion Square, Dublin (March 1).

Assistant Lecturer in Physics at the University College of the West Indies—The Secretary, Inter-University Council, 1 Gordon Square, London, W.C.1 (April 1).

I.C.I. **Research Fellowships** in Bacteriology, Biochemistry, Biomolecular Structure, Chemical Engineering, Chemistry, Chemistry of Leather Manufacture, Chemotherapy, Colour Chemistry and Dyeing, Engineering (Civil, Electrical or Mechanical), Fuel and Refractories, Geology (including Geochemistry), Metallurgy, Mining (Selective Flotation and Geophysical Surveying), Pharmacology, Physics, Physiology, Textile Industries (Protein Chemistry)—The Registrar, The University, Leeds 2 (April 30).

I.C.I. **Research Fellowships** in Biochemistry, Chemistry, Engineering, Pharmacology, Physics or allied subjects—The Academic Registrar, University of London, Senate House, London, W.C.1 (April 30).

I.C.I. **Research Fellowships** in Chemistry, Physics and allied subjects—The Registrar, The University, Manchester 13 (April 30).

Turner and Newall Research Fellowship in Engineering, Inorganic Chemistry, Physics, or an allied subject—The Academic Registrar, University of London, Senate House, London, W.C.1 (April 30).

Assistant Micro-Analyst (woman) in the Department of Chemistry—The Registrar, The University, Nottingham.

Lecturer in the Department of Electrical Engineering—The Registrar, Municipal College, Portsmouth.

Mechanical Engineer (young, with good honours degree and preferably some experience of research methods) for experimental investigation of stresses in motor vehicle components—The Director, Motor Industry Research Association, Great West Road, Brentford, Middx.

Metallurgist for work on surface metallurgy and metallurgy of coating processes—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1.

Physicist (graduate assistant, preferably with experience in electrophysiological and/or radiological techniques)—The Secretary, Nuffield Institute for Medical Research, 43 Woodstock Road, Oxford.

Physicist (honours graduate with interest in properties of matter or mathematical physics) for fundamental research—The Secretary, British Rayon Research Association, Barton Dock Road, Urmston Lancs.

Physicist (preferably graduate) for combustion and heating problems—The Assistant Secretary, British Coal Utilisation Research Association, Randalls Road, Leatherhead, Surrey.

Scientific Assistant for abstracting from foreign, especially Slavonic, literature on horticultural science—The Director, Commonwealth Bureau of Horticulture and Plantation Crops, East Malling, Kent.

Engineers (Hydraulic) and **Engineers** (Hydrology) in the Hydraulics Branch of the Public Works Department, Kenya—The Director of Recruitment (Colonial Service), Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27322/11 for Engineers (Hydraulic), and No. 27322/22 for Engineers (Hydrology).

Plant Chemists to undertake supervisory duties in connexion with the operation of a large chemical plant, **Plant Engineers** to undertake the maintenance of chemical and allied plant, and a **Plant Instrument Engineer** (Springfields only) to be responsible to a Senior Engineer for the maintenance and development of instruments at the factory, in the Ministry of Supply Division of Atomic Energy (Production), at Springfields Factory near Preston, and Windscale Works, Sellafield, Cumberland—The Administration Branch, Division of Atomic Energy (Production), Risley, near Warrington, Lancs.

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HUMAN RIGHTS AND DUTIES

IT is now more than a year since a Universal Declaration of Human Rights was adopted by the Assembly of the United Nations. This, however, was intended as only the first stage in the preparation of a Universal Bill of Human Rights which the United Nations has been inspired to undertake, largely in the belief that the rule of international law and the protection of fundamental human rights are essential both for the survival of civilization and the continued existence of the human race. A powerful impetus to the protection of the freedom of individual citizens from tyranny has been provided by war-crimes trials, but discussions are still proceeding on the second and third stages of the proposed Bill, namely, a Covenant on Human Rights and the measures of implementation. Meanwhile, the European Movement, from which has come the Council of Europe, has been giving attention to this question, and in particular to the need for a European convention. A draft European convention for the collective protection of individual rights and democratic liberties by member States of the Council of Europe, and for the establishment of a European court of human rights to ensure observance of the convention, with a draft statute for such a court, were submitted by the European Movement to the Committee of Ministers of the Council of Europe on July 12, 1949. This draft was accompanied by a recommendation that the whole question of the maintenance of human rights and liberties should be placed upon the agenda of the first session of the European Consultative Assembly at Strasbourg.

These documents are included in a useful reference book, "European Movement and the Council of Europe", published on behalf of the Movement*, to which Lord Russell contributes a chapter on Europe's cultural heritage. The reason for tardy progress is shown clearly in the symposium on human rights, edited by Unesco, which has in the meantime been published†. Whereas the idea of a court of human rights is derived largely from the belief that a code of international law is required which individuals and governments alike would be obliged to respect, the contributions to this symposium show unmistakably that there is one school of thought which is looking to the erosion of the law, rather than to its clarification and strengthening as the bulwark of individual liberties against tyranny in the way that Lord Justice Denning suggested in his recent lectures on freedom under the law.

This aspect is brought out most clearly in Prof. Sergius Hessen's contribution, though it can also be traced in those of Mr. John Lewis and Prof. Boris Tchechko. Prof. Hessen, in a long essay on "The Rights of Man in Liberalism, Socialism and Communism", recognizes that this doctrine of the withering away of State and law, however consistent and noble in its final aim, which, it will be noted, has affinity with the Pauline doctrine expounded in the

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* European Movement and the Council of Europe. Pp. 203. (London: Hutchinson and Co., Ltd., 1949.) 10*s*. 6*d*. net.

† Human Rights: Comments and Interpretations. A Symposium edited by Unesco; with an Introduction by Jacques Maritain. Pp. 288. (London: Allan Wingate (Publishers), Ltd., 1949.) 15*s*. net.

Epistle to the Romans, is decidedly hostile to the very idea of the rights of man and of the liberties of the individual. Prof. Hessen, moreover, points out that the doctrine is unable to provide a programme for constructive work, and he proceeds to elaborate what is involved for science and technology on this very issue in the development of a new ideology and superstructure if we accept Communist premises.

There is no more thoughtful or stimulating essay in this symposium than that of Prof. Hessen, although to say that is not necessarily to accept his argument and views on the origin of the spiritual values in the Western tradition of civilization, their influence on the development of science and technology and the possibility of a new synthesis which incorporates that tradition of the rights of man. The concessions, in his view, are all to come from one side, and his essay, admirable as it is, seems to underline the conclusion of that of Prof. Kurt Riezler, that any bill of rights making those rights conditional on duties towards society or the State—however strong its emphasis on human dignity, freedom, God or whatever else - can be accepted by any kind of totalitarian leader. Such a leader would enforce the duties while disregarding the rights. Hence, Prof. Riezler urges, a bill of rights would be better restricted to rights, that is, to those rights which as minimum conditions, however insufficient, of human freedom, any State or society can respect and protect. These are the old civil liberties, and any addition, be it of economic rights or of duties, means in practice weakening the civil rights and their hold on the human mind. This view is in harmony with the draft convention submitted by the European Movement which would guarantee only those fundamental personal and political rights which it is practical to enforce in courts of law.

Nevertheless, this conclusion seems scarcely to face the point that it is on these two issues—the need to add economic to political rights, and the need to consider the duties as well as the rights of man—that most thinkers of to day are conscious that the old eighteenth-century formulæ are inadequate. It may be true enough that we need, as General Smuts has put it, not only freedom but also discipline, and if we could be sure of the discipline, the practical difficulties in reconciling the Western and the Communist interpretations might disappear. In practice there is, however, no evidence of that; and the present symposium, while emphasizing the extent to which the addition of social and economic rights to the political rights so important in the eighteenth century has marked the modern conception of the rights of man, stresses, too, the need for remembering that rights cannot be divorced from duties.

The problem of reconciling political equality with political freedom is less simple than it appeared down to the time of J. S. Mill; and although we are here offered no solution, these essays should stimulate fresh and searching inquiry into the whole subject. They probe the claims advanced at present by both sides, and indicate a certain insincerity in the claim of either to offer a formula which makes the best of both worlds. In truth, it must be recognized that, as Prof. Quincy Wright points out, every formulation of a human right raises the issues of man versus the group, of group versus group, and of group versus the world; and on the answers we give, on which we are the final interpreter, depends whether or not society dissolves in anarchy, in war or in tyranny. In the definition of human rights, we must consider both the original nature of man and the contemporary standards of world civilization; and the human rights must be stated in terms which recognize their relation to the requirements of the State and to the authority of the world organisation. The implementation of each right must develop independently and gradually as the world community develops.

On the broad issue it may be said that the symposium only initiates the inquiry which Prof. E. H. Carr suggests should precede the drafting of an international declaration. No declaration of rights, he holds, would have any validity to-day if it did not include social and economic as well as political rights, nor would it have any serious meaning. Further, any declaration of rights and obligations of the individual in society should at the present stage be regarded as a declaration of intention, or as a standard to be achieved, rather than an internationally binding engagement. Benedetto Croce, too, suggests that Unesco's practical contribution should be a formal, public and international debate on the necessary principles underlying human dignity and civilization; but that the value of such a debate would largely turn on whether the present confusion in the use of terms could first be removed.

It is on agreement as to the meaning of the terms we use that the possibility of transcending ideological conflicts depends. Otherwise it is impossible to discuss such conflicts, as Prof. F. C. S. Northrop suggests, in the light of empirical and scientific evidence or to resolve them by means of scientific inquiry. But if Prof. Northrop is right in urging that the minimum foundation for a bill of rights is a political philosophy which is both a philosophy of all the world's cultures and a philosophy of science, there is little prospect that an adequate declaration will be formulated for decades to come.

It is not only in the field of philosophy that fresh thought is required. The symposium directs attention also to the failure of Western democracy to give sufficient thought to transferring the conception of independent public service to the conditions of mass democracy. That is the real issue which Lord Beveridge raised in his "Voluntary Action", and it is as important in the scientific as in the political field. Indeed, it may be said that the failure during the past two centuries to recognize that any definition of the rights of man is also a definition of the relation between the individual and society, and to think out in terms of rights and obligations the implications for both sides of the shift in emphasis, is a fundamental cause of the present problem of work incentives.

What is immediately required is, as has already been indicated, searching inquiry and constructive thought before legislation is drafted. Prof. Northrop at least recognizes by implication that one element in a bill of rights must be some guarantee of freedom for scientific and philosophical inquiry; and the contributions to this symposium from Aldous Huxley, Prof. R. W. Gerard, Prof. J. M. Burgers and Prof. W. A. Noyes have the strongest claims on the interest of men of science. It is to be hoped, however, that they will not neglect to pursue also the lines of thought opened up by René Malen in a discussion of what is involved in the right to information and the right to the expression of opinion, or by Prof. I. L. Kandel's analysis of education and human rights. The former bears closely on a vexed problem with which science is increasingly concerned, and the latter subject needs all the help which an objective and impartial approach can contribute.

Of the remaining essays, Aldous Huxley is most interesting in his comments on the ethical problems which confront scientific workers as individuals or as members of professional organisations, though he reminds us also that science can do something to render certain features of the general problem of human rights more tractable by diminishing the pressure of population upon resources. He refers also to the population aspect in a comment that it remains to be seen whether personal liberty, group co-operation and local and professional self-government —the three essential elements of a genuine democracy —are compatible with the qualitative deterioration of the population; but the biological approach is discussed more particularly by Prof. Gerard. Here again we find emphasis laid on the relativity of rights to the society, and on the falsehood of any doctrine which regards man only as an individual or only as a unit in a group.

What is brought out most clearly by Prof. Gerard is the dynamic character of the problem. Rights are changing, and some must be abrogated as new ones are demanded. It is imperative that provision should be made for re-examination and re-formulation at intervals. In that respect the biological approach leads us, not to the withering away of codes and laws, but to their ordered revision and adaptation to changed conditions, as Lord Justice Denning indicated in his lectures. Prof. J. M. Burgers, on the other hand, limits his contribution to the consideration of the rights and duties involved in creative expression, particularly in science, both those of the community and those of the individual and his professional group. He comments more particularly on the problems of freedom of expression and of scientific and philosophic inquiry, and in particular on the dangers which attend the introduction of legal secrecy restrictions into science.

That is a particular issue which cannot be discussed here; but Prof. Burgers shows clearly how much more is involved in it than the development of science as a pursuit of truth or its application in ways that can be adequately and ethically justified. The effects on civic rights may be far-reaching and destructive, and distrust and suspicion instead of co-operation may be caused between groups and nations. Prof. Burgers himself is prepared to accept any risks at present involved in the free communication of discoveries in what is now the forefront of scientific advance; but he seems to overlook the fact that it is reciprocity and intercommunication of minds that are responsible for stimulating creative thought and scientific advance and not just traffic in one direction.

Prof. W. A. Noyes's brief contribution is essentially a warning that the conflict between nationalistic aspirations and the need for a broader outlook will not speedily be resolved, and that certain rights of scientific workers, and consequently certain rights of man, must be curtailed for the common good. He suggests that apart from helping to eradicate poverty and disease, the greatest contribution scientific workers can make in preserving the rights of man is to educate the world into a free discussion of all matters without personal animosity. On his side, the man of science must temper his intolerance towards errors in fact and in logic with a real tolerance towards varying basic postulates in the social sphere. Prof. Noyes concludes that the immediate objective of the man of science should be to ensure that all levels of society in all nations are freed from economic anxiety; if this be done, then given a sufficient period of peace, the rights of man can be worked out and a code of ethics evolved which will fit the human race into a scientific world.

Like most of the contributors to the symposium, Prof. Noyes raises fully as many fresh problems as he discusses. Nevertheless, the symposium is a serious attempt to reach the fundamental issues; and it is above all a challenge to thought and inquiry, and a warning against any hasty or premature codification. While the contributions, in the main, concentrate attention on the general issue of the rights of man, they repeatedly indicate how important a contribution scientific workers can make to the inquiry and thought that are required for a reasoned approach to this difficult problem.

ARCHÆOLOGY AT JEBEL MOYA, SUDAN

Wellcome Excavations in the Sudan

(Published for the Trustees of the late Sir Henry Wellcome.) Vol. 1: Jebel Moya (Text). By Frank Addison; with a Chapter by A. D. Lacaille. Pp. xiv+399. Vol. 2: Jebel Moya (Plates). Pp. viii+117 plates. (London, New York and Toronto: Oxford University Press, 1949.) 2 vols., 126*s.* net.

THE aura of mystery concerning the results of the long-awaited excavations at Jebel Moya in the Gezira of the Anglo-Egyptian Sudan, which their instigator and patron, the late Sir Henry Wellcome, deliberately did nothing to dispel, is at last, after twenty-five years, extinguished by the appearance of these nobly produced volumes. Mr. Frank Addison, formerly curator of antiquities, Sudan Government, who was eventually entrusted with their publication, has had the thoroughly unenviable task of compiling the records of this long-ago enterprise of 1911–14, in which he took no part, from the field-notes and other documents of the archæologists who conducted it before the First World War interrupted, for ever as it proved, its intended continuation. That little company of archæologists, which includes the respected names of Oric Bates, James Dixon, Duncan Mackenzie, G. A. Wainwright and O. G. S. Crawford, is itself disbanded, the first three being dead. Wainwright served for a few weeks only; Crawford in his one season conducted a separate excavation, to be published by him in a later volume.

Mr. Addison, then, in accepting publication, courageously shouldered, practically unaided, a task charged with interpretational dangers, difficulties of syntheses of sometimes badly co-ordinated records, and, above all, dubious levels. These were doubtless consequent to some extent on the seasonal change of archæologists in charge; yet they seem to have been primarily due to a fantastic excess of workmen, for which the professional staff was in no way to blame, coupled with the observance of Mr. (later Sir Henry) Wellcome's express wish that no scrap of material, however useless or undocumented, should be discarded, which must have taxed the recording staff beyond endurance. An instance of what Mr. Addison has patiently had to disentangle is revealed by the duplication in the object registers of all numbers up to 3,465, consequent upon the introduction in the third season of a new recording system which began again at the beginning.

More fundamentally serious, however, was the preliminary omission to contour the site before excavation, and control its variable but potentially useful stratigraphy (where not disturbed by numerous graves) by test trenches, and to fix once and for all well-considered datum-levels in place of the arbitrary surface-level upon which far too much reliance seems to have been placed. Inasmuch as the site lies in an upland valley basin bounded by hills, and has been subjected to unequal processes of deposition and erosion, natural and artificial, the inadequacy of depths below present surface is more than usually apparent. Mr. Addison is fully aware of this state of affairs and has evidently taken infinite care to rectify all in his power, perhaps even to the extent of over-reconstruction by methods lucidly explained. In the last resort, however, it is clear that the objects must date themselves, rather than form a stratified series which, for the undatable pottery and flint implements, would have been an invaluable and permanent contribution to Ethiopian cultural history.

Mr. Addison concludes that both the occupation of the site and the 2,800-odd graves in it may in date be contained within the last millennium B.C. An initial occupation, probably round about 1000–900 B.C., by people most probably from the Western Desert in a purely Neolithic culture stage with impressed pottery and stone artefacts, reached its zenith in the Napatan period; and direct contacts with Napata are shown by small objects including scarabs which range in style and/or period from the Egyptian late New Empire to the Twenty-Sixth Dynasty (663–525 B.C.). The site was virtually abandoned before the beginning of the Meroitic period (about 300 B.C.). The continuity of racial type, if any, will be judged by subsequent publication of the skeletal material. Much of this will be unquestioned. None the less, even an archæologist as unfamiliar with the material cultures of ancient Ethiopia as the present reviewer cannot help wondering, on studying the excellent plates, if earlier material is not perhaps included; for not only do certain bowls recall the Nubian C-group, but also some of the stone and bone artefacts, particularly the bone adzes or chisels on Pl. LVII*a*, appear closely to resemble similar objects, believed prehistoric (in the Egyptian sense), from one of Mr. A. J. Arkell's recent discoveries of two new early cultures in the Sudan.

On the other hand, the range of microlithic implements of Jebel Moya which look so archaic, and which undoubtedly first appeared in Africa at a remote period, need occasion no surprise in late contexts such as Jebel Moya. They include elements in common with obsidian and chert microliths found by the reviewer in tombs in South Arabia dated by seals showing Achæmenian influence, and which probably date to Achæmenian times[1]. South Arabian contacts with Ethiopia at much the same period are suggested also by the small pottery vessels referred to in the Jebel Moya publication as "spouted feeding-cups", which are believed to date there to the latest period of occupation. Some attention is given to their geographical connexions, and the closest parallel cited is a French Neolithic settlement. It is unnecessary to travel so far in space and time, when the Hadhramaut tombs, already quoted, produced similarly tubular-spouted vessels which, though not identical in detail and more sophisticated, are closely akin. One of them was inscribed "perfume" in Himyaritic characters[2]. G. CATON THOMPSON

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[1] Caton Thompson, G., "The Tombs and Moon Temple of Hureidha, Hadhramaut". Report of the Research Committee, Society of Antiquaries, **13**, 93 (1944).

[2] *ibid*. 124.

SCHOOL SCIENCE IN AMERICA

New Directions in Science Teaching

A Report of a Cooperative Project in Seventeen Secondary Schools with the Bureau of Educational Research in Science, Teachers College, Columbia University. By Prof. Anita Duncan Laton and Prof. Samuel Ralph Powers. Pp. xi+164. (New York and London: McGraw-Hill Book Co., Inc., 1949.) 15*s*.

THIS book describes and interprets the experiences of a widespread group of American teachers who co-operated with the Bureau of Educational Research in Science in applying modern educational theory concerning project and activity methods, and the applications of studies to the problems of living, to the education of 'senior high school' children (the nearest equivalent in Britain would be the secondary modern schools). Account has been taken of recent advances in educational theory and science, including investigations in growth and development of children, use of community resources, the learning process and group planning.

The method used in this small book is to take the ideas of outstanding science teachers in schools in various parts of the United States. The ideas are tried out by research associates in 'curriculum workshops', and there is a list of external consultants which is quite impressive. The book does not give instruction in the techniques of science teaching in classroom, lecture room or laboratory, and on the whole it deals merely with themes and topics. An example of the methods employed is shown by this extract: "The School nurse at George Rogers Clark School in Hammond found, by questionnaire, students' ideas of care of illness. She discovered, for example, that students thought one could cure a cold by 'wearing it out', taking aspirin, taking a good dose of whiskey, taking castor-oil or going to bed. Similar beliefs were found as to the cause and treatment of headaches and other minor ailments. These beliefs helped shape the teaching of the course in biology where stress was given to problems of home nursing." The Denby High School lists three fundamental needs: (1) the development of a long-range social point of view based on scientific principles; (2) the development of a desire to do something about social problems; (3) the development of ability to work co-operatively on the analysis and solution of problems. In the schemes of work there is an attempt to integrate the science subjects and also to achieve a newer synthesis of the sciences with other branches of knowledge such as the social studies, history, English, and so on.

All this is not new to the progressive teacher in a British secondary school, where 'reality in the classroom', 'projects' and social studies are being developed. Such treatment is particularly useful for the non-specialist in science, but it may be that a word of warning is necessary. Since 1902 a general high level in science has been built up in British grammar schools, and many of the 'public schools' have a somewhat longer tradition in these matters. No doubt 'project' and 'reality' methods can effectively replace the old 'heurism', and there is still room for a wider knowledge of the applications of science to the improvement of society; but the loss to science standards in Great Britain would be incalculable were anything to replace the sound training in fundamental principles and laboratory measurements which has characterized most of the grammar school science during more than four decades.

W. L. SUMNER

A CHEMICAL TECHNOLOGIST LOOKS AHEAD

Farmer Victorious

Money, Mart and Mother Earth. By William J. Hale. Pp. xii+241. (New York: Coward-McCann, Inc., 1949.) 3 dollars.

THE author of this book, Dr. W. J. Hale, was chairman of the Division of Chemistry and Technology of the National Research Council, Washington, D.C., and is now consultant to an important American chemical company. Like many others, he feels that the blessings that our fathers expected from the enormous developments of science and technology have not materialized; something has gone wrong. He considers he has discovered the fault—the money-lending on which the trading and banking systems of the world are based. The elimination of this fault requires the abolition of international trade and the re-organisation of the nations of the world into four blocks or sections: Anglo-American, Latin-Teutonic, Slav, and Mongolian, each of which would be self-sufficing and would have no occasion to trade with the others, though some tourist traffic would apparently be permitted. All small nations would simply disappear; the pound sterling would vanish and be replaced by the dollar, the U.S.S.R. would be encouraged to expand still further and acquire "a deep southern domain", and Africa would largely become an appendage of the Latin-Teutonic section. India is not mentioned, being apparently too small for consideration. With all this part of the story, and the denunciations of business men, "crackpot" politicians, and the supposed "tame" scientific workers who meekly obey them, we need not concern ourselves.

The technological part of the book is based on the thesis that the farm is a much better source of raw materials for the chemical manufacturer than coal or oil, inasmuch as its resources are inexhaustible. "We need to apply ourselves more diligently," the author says, "to harness the four million kilo-watt hours of the sun's energy that falls daily on every square mile of the earth's surface." The statement is typical of the whole book. The plant synthesizes carbohydrates which can be fermented to produce ethyl alcohol, which is not only an excellent source of power but also a starting material for making synthetic rubber and many other things. Oat hulls and corn cobs yield furfurol, out of which nylon can be made; castor oil seems even more promising. Each type of plastic, however, requires its own crop. Factories should be set up to deal with all farming products, even weeds; direct food production would become a subsidiary activity, and meat would be replaced by synthetic amides. Such food as was grown must be produced without the use of synthetic fertilizers; only composts, the trace and 'basic' elements, and, apparently, nitrogenous fertilizers, being permitted. A special chewing-gum would ensure ample supplies of vitamins and other essentials.

Those interested in blueprints for the 'New Age' may like to add this to their collection; it differs from those of Aldous Huxley, Vogt and Osborn in forecasting illimitable supplies of farm products which can be worked up into all things needed by man, though it does not say how these vast quantities can be obtained.

E. J. RUSSELL

ELECTROMAGNETIC INDUCTION

Faraday's Discovery of Electromagnetic Induction By Thomas Martin. Pp. 160+4 plates. (London: Edward Arnold and Co., 1949.) 9s. net.

MICHAEL FARADAY carried out the greater part of his experimental researches within the Royal Institution, Albemarle Street, London, and it was characteristic of him that he made notes, in diary form, of his investigations and occasionally his speculations. Mr. Thomas Martin, general secretary of the Royal Institution since 1929, edited the printed version of "Faraday's Diary" published during 1932–36 in seven volumes. While engaged on this task, Mr. Martin delved deeply into Faraday's published papers and other contemporary and later sources of information. In the present little work, he has selected one of Faraday's major investigations —and perhaps his most important—namely, electromagnetic induction, and presented it in the light of contemporary views of the nature of electricity and magnetism. By quoting extensively from the "Diary", he enables the reader to follow Faraday's thoughts and work on the subject over a period of years, culminating in about six months of almost continuous work in late 1831 and early 1832 which served to establish the main facts of electromagnetic induction, the basis of modern electrical engineering. Having discovered the effect on August 29, 1831, Faraday quickly verified his observations, and then passed on to obtain a flow of induced electricity by means of a rotating copper disk and finally extended the work to induction by the earth's magnetism.

The book is illustrated by reproductions of many of the quaint little sketches drawn by Faraday in his notes and by photographs of apparatus he used which is still in the keeping of the Royal Institution.

THE HARWELL CYCLOTRON

By T. G. PICKAVANCE, J. B. ADAMS and M. SNOWDEN

THE cyclotron at the Atomic Energy Research Establishment, Harwell, on which work was started in the autumn of 1946, has been operating since the beginning of December 1949, and is producing protons of energy about 180 MeV. It is of the frequency-modulated type first developed by E. O. Lawrence's team in the University of California[1].

The application of frequency-modulation has greatly increased the energy to which particles can be accelerated in a cyclotron. In the ordinary cyclotron, ions are accelerated in spiral orbits in a uniform magnetic field by the repeated application of a potential difference from a fixed-frequency oscillator. The frequency of the accelerating voltage must be synchronized with the circulation of the ions in their orbits. However, the angular velocity of charged particles moving in a uniform magnetic field decreases with increasing energy, on account of the relativistic increase of mass, and this effect becomes serious in practice at a velocity of about one-tenth that of light. The ions suffer a growing phase-lag with respect to the accelerating voltage, as their velocity increases, and this is made worse by the necessity for focusing the ion beam towards the median plane of the magnet gap; the only effective method of doing this is to arrange for the magnetic field to decrease slightly with increasing radius. If, therefore, we were to attempt to synchronize the orbital motion of the particles by increasing the magnetic field with the radius, we should lose the beam through the strong defocusing action of the magnetic field. Without attempting any form of synchronization, but by using a high accelerating voltage (100–200 kV.), particles may be accelerated to about 10 MeV. for protons, 20 MeV. for deuterons or 40 MeV. for the doubly-charged helium nuclei. This limit corresponds roughly to a cyclotron of 60 in. diameter.

A means of overcoming this difficulty was suggested independently by Veksler[2] and McMillan[3], who showed that charged particles circulating in a cyclotron may possess the property of phase stability. Under certain conditions a particle can travel in a stable orbit, oscillating in phase, radius and energy with finite amplitudes about equilibrium values determined by the magnetic field, the frequency of the electric field and the ratio of charge to total mass of the particle. Veksler and McMillan showed that, by slowly increasing the magnetic field with time, reducing the frequency, or both, the orbit can be made to expand and the energy to increase. M. L. E. Oliphant independently proposed a similar method of accelerating particles (unpublished). In all accelerators based on these principles, the particles can remain in synchronism with the accelerating field despite the relativistic increase of mass and the shaping of the magnetic field for focusing, and in practice the energy obtainable is limited by economic rather than technical considerations. In the frequency-modulated cyclotron, or synchro-cyclotron, the magnetic field is fixed and the frequency of the accelerating voltage is progressively reduced during acceleration. Acceleration begins when the frequency has the correct value for ions of low velocity, and continues until the frequency has reached the appropriate value for the final conditions of magnetic field, orbit radius and particle energy. The frequency is varied cyclically, and the particles reach the target in pulses, at intervals determined by the repetition-rate of the frequency-modulation cycle.

The 184-in. California cyclotron has been producing about 1 microampere mean current of 190-MeV. deuterons and 350-MeV. protons for some time, and valuable research has been carried out by its use. Other large cyclotrons are operating or under construction in the United States, and several are being built in Europe. The Harwell cyclotron is the largest so far operating in Europe, and will be the only one of its kind in Britain until a new and larger cyclotron has been built in Liverpool.

The Equipment

The magnet of the Harwell cyclotron has straight-sided poles, 110 in. in diameter and 12 in. apart. The yoke and poles are built of 670 tons of low-carbon steel in 10-ton plates, and the windings contain 70 tons of copper strip, are oil-cooled and consume 355 kW. for the normal centre field of 16,500 gauss. The pole faces are contoured in such a way that the vertical component of magnetic field falls off approximately linearly with increasing radius, from the centre to as great a radius as is practicable, to provide adequate magnetic focusing for the ion beam; the maximum usable radius (expected, according to the Berkeley results, to correspond to $n = 0{\cdot}2$, where $n = -\frac{r}{H}\frac{\partial H}{\partial r}$) should be 50·4 in., and the magnetic field at this radius is 15,725 gauss. A stainless steel vacuum chamber is sealed to the sides of the magnet poles, and is evacuated to a pressure of less than 10^{-5} mm. mercury by oil-diffusion pumps with a speed of 10,000 litres per second; the total volume of the vacuum system is about 12,000 litres.

A single copper accelerating electrode (the 'dee') is mounted between the magnet poles, with a grounded copper sheath which concentrates the electric field and effectively forms a second 'dee'; the 'dee' is connected to a system of resonant coaxial transmission lines coupled to a single 150-kW. triode valve to form a grounded grid oscillator. One of the 'dee' lines is terminated by a motor-driven variable condenser, which varies the resonant frequency over the range 26·5–20 megacycles per second for the acceleration of protons and is placed in a region of low magnetic field, to avoid eddy-current losses in the rotating parts. The whole of this circuit is water-cooled, and the lines and condenser are included in the main vacuum system. A D.C. bias voltage can be applied to the 'dee' and lines, for the collection of stray electrons which would otherwise oscillate in the radio-frequency field and produce discharges, heavily loading the oscillator.

The protons are produced by a low-voltage filament-maintained arc discharge in an ion source at the centre of the magnet poles, in the accelerating gap between the 'dee' and its grounded sheath. An adjustable probe-target may be set at any distance from the centre, so that the proton beam may be intercepted at any desired energy. Apparatus up to about 8 in. cube may be inserted through an air lock, for irradiation on the probe, without disturbing the vacuum.

Elaborate shielding is needed, since the neutrons ejected from the target by the proton beam are very penetrating. The cyclotron is installed underground, with a 6-ft. thickness of concrete overhead, and is remotely controlled by a system incorporating safety interlocks and protective devices.

Performance Characteristics

The cyclotron is being operated with a peak 'dee' potential of about 5·5 kV., obtained with 12 kW. average D.C. input power to the oscillator, and a D.C. 'dee' bias of 500 V. is sufficient to prevent discharges. The average acceleration per traversal of the 'dee' gap is about 3 kV. Under these conditions, the protons circulate about 30,000 times in travelling from the ion source to a radius of 50 in., to acquire a kinetic energy of a little less than 180 MeV., corresponding to about half the velocity of light. In contrast, the number of circulations in a conventional cyclotron with fixed frequency is usually about a hundred, with a much higher 'dee' voltage and radio-frequency power.

The frequency-modulation cycle is repeated at a frequency of about 80 cycles per second, so that the beam pulses are separated by about 12 milliseconds; the duration of the beam pulses varies with the operating conditions, but is usually of the order of 100 microseconds. The beam current is not very sensitive to variation of the repetition-rate or to small changes in the magnetic field; but under the present conditions of operation it rises rapidly with increasing 'dee' voltage. It is planned eventually to increase the 'dee' voltage to 12 kV. and the repetition-rate to 200 cycles per second. At present the mean beam current is about 0·5 microampere, which may be considered satisfactory for a frequency-modulated cyclotron in the initial stages; it should be considerably increased as development continues.

Measurements of the neutron and γ-ray intensities outside the cyclotron pit show that the shielding is adequate, and that it has a considerable safety margin for operation at higher beam currents. A preliminary measurement of the fast neutron output gives a value about 10^{10} neutrons of energy above 50 MeV. per unit solid angle per second, in the centre of the neutron beam produced by proton irradiation of a copper target. A bismuth fission chamber, which is only sensitive to neutrons of above 50 MeV., was used in this determination.

Programme of Work

At first, a considerable proportion of the running time will be devoted to development of the machine, with the object of increasing the beam current and extracting the beam. Some work has already been done on the extraction problem; but many experiments can be done using an internal beam. In particular, neutron experiments can be performed in this way; a fairly well-defined beam of neutrons of energies ranging up to the full proton energy is produced when the protons fall upon an internal target, and a thin window in the wall of the vacuum chamber allows the neutrons to enter the detecting apparatus outside, with negligible attenuation and scattering.

The first neutron experiments will be measurements of the total cross-section for attenuation of neutrons by a wide range of elements as a function of neutron energy. Since these experiments will involve a measurement of the energy distribution of neutrons produced by 180-MeV. protons, in various targets, they will provide a basis for further work with neutrons.

At the full energy of 180 MeV., it should be possible to produce mesons, and attempts will be made to observe them in photographic emulsions. The yield of mesons at this energy is known to be rather small, and therefore it is planned to spend only a small proportion of running time on meson experiments. Other experiments with photographic plates will be concerned with nuclear explosions produced by protons and neutrons, and similar work will be done with cloud chambers. These very high-energy nuclear reactions will also be investigated by radiochemical methods, and there is a small 'hot' laboratory, connected to the cyclotron by a pneumatic delivery system for handling short-period activities.

We wish to acknowledge the valuable assistance of many industrial firms, in particular of Messrs. C. A. Parsons and Co., Ltd., who constructed the magnet, which was the biggest industrial contribution. The more specialized parts of the cyclotron were built by the Engineering Division at Harwell, and civil engineering and electrical work were done by Ministry of Works contractors.

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[1] Richardson, J. R., *et al.*, *Phys. Rev.*, **73**, 424 (1948).
[2] Veksler, V., *J. Phys. U.S.S.R.*, **9**, 153 (1945).
[3] McMillan, E. M., *Phys. Rev.*, **68**, 143 (1945).

CRAZING OF CAST POLYMETHYL METHACRYLATE*

By E. W. RUSSELL
Royal Aircraft Establishment, South Farnborough

THE phenomenon of crazing of brittle plastics is one to which frequent allusion is made in the technical literature, but which has been little studied in detail. It has been defined[1] as "fine cracks which may extend in a net-work over or under the surface of or through a plastic". In transparent plastics, the cracks are readily visible to the naked eye by reflexion from their surfaces and appear as bright lines or spots as the specimen is held at varying angles to the incident light. The effect has been ascribed to the volatilization of monomer or other volatile impurity in the material, and also to internal stresses[2]. It has been observed[3,4] in polymethyl methacrylate, polystyrene, cellulose derivatives and some vinyl polymers. A similar effect has been described in phenolic resins exposed to acetone[5].

The practical importance of crazing lies in the change of properties which it produces. Light transmission may be reduced by it when present as a haze, and, by distracting the attention of the viewer, local patches of crazing may interfere with vision at times when rapid and accurate identification of objects is essential. Furthermore, surface defects

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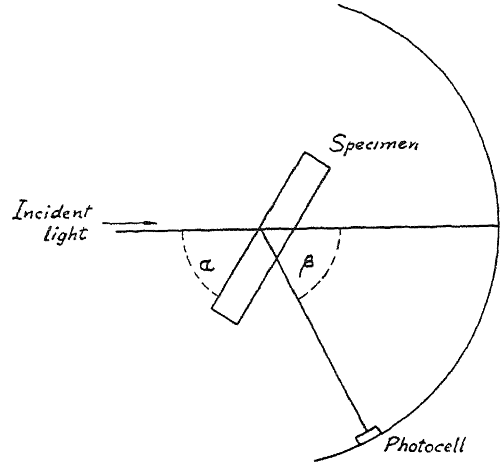

Fig. 1

influence the structural properties of the material. The high notch-sensitivity prevents the attainment of the designed strength of a structure, so that such defects must be regarded as incipient failure. Also, according to Bartoe[6], very small changes in the depths of scratches are accompanied by large reductions in impact strengths.

Forms of Crazing

A great variety in the form and disposition of the system of cracks is observed, depending on the conditions under which the crazing is produced. The size of the cracks may vary from those visible directly to the naked eye to those which are apparent only as haze or translucence producing scattering of light.

Deeg[7] studied the permeability to water vapour of plastic films and showed that crazing, like porosity, gave erroneous results. Vieweg and Schneider[4] measured the distribution of light transmitted by plates of polystyrene oriented at various angles to the incident beam. They found in addition to the maximum by direct transmission a second maximum in the light intensity at angles such that $180° - \beta = 2\alpha$ (Fig. 1). This they attributed to reflexion by internal inhomogeneities, which they showed microscopically to consist of small cracks preponderantly perpendicular to the face of the samples. When a crazed sample is immersed in a good solvent, the polymer breaks up along the lines of the worst crazing before swelling and dissolution is complete. This suggests that penetration occurs through cracks which have been produced at those points. There is thus evidence that crazing consists of fine cracks; other facts in agreement with this hypothesis will emerge.

The variety of the patterns produced by the crazing of polymethyl methacrylate when viewed under the microscope is most marked. There are two main groups of conditions for the production of the effect, and the differences between them become more evident when so observed. The application of large mechanical stresses to the material is characteristic of one such group (*stress crazing*); in the other, crazing is induced by the action of chemical agents (*solvent crazing*). These two types are not mutually exclusive, so that the effect may be produced by the simultaneous action of stress and solvents; internal stress is, in fact, essential to crazing under the influence of solvents.

When subjected to mechanical stressing, methacrylate samples craze on those faces which are in tension. Purely compressive stresses do not produce the effect. The direction of the fissures is at right angles to that of the applied stress. Such a pattern viewed by normal transmitted light (× 35) is shown in Fig. 2. The physical dimensions of the crazing pattern appear to vary with the sample thickness, though the control of other variables is difficult and introduces some uncertainty into this conclusion. Gross crazing is observed in thick test pieces, whereas a fine haze occurs in thin films which under sufficiently high magnification is similar in appearance to Fig. 2. A highly plasticized material exhibits grosser crazing than the unplasticized polymer. Monomer in an incompletely polymerized product behaves as plasticizer, and therefore heat treatment causing further polymerization of the monomer markedly lowers the tendency of such a sample to craze.

Certain samples craze when exposed to the action of some liquids or their vapours. Any liquid which will swell or dissolve the polymer can produce this effect; with good solvents the effect is almost instantaneous.

The system of fissures produced by solvent attack is apparently randomly oriented, unlike those produced by directional tensile stressing. The cracks appear to start at a series of separated points, usually as a *V*- or *Y*-shaped mark from each; such incipient crazing is shown in Fig. 3. These cracks then join up to form a continuous pattern of varying coarseness. On prolonged exposure, swelling of the polymer disturbs the whole surface and the effect of the cracking is masked. The final stage of breaking up before dissolution is readily visible to the naked eye.

An important observation is that the clear surface obtained by breaking a cast sheet failed to craze, although the original surfaces both crazed badly on exposure to solvent. Cut and polished edges behaved similarly, but local heating during the finishing process may have minimized any possible effect.

When the methacrylate is subjected to a tensile stress of a lower magnitude than that required to induce normal stress crazing, the effect of vapour is enhanced. This combined effect of stress and vapour has been used to test[8] the crazing resistance of material and the crazing effects of various agents upon it. Conversely, the crazing of polystyrene in solvent has been used[2] to follow the annealing process.

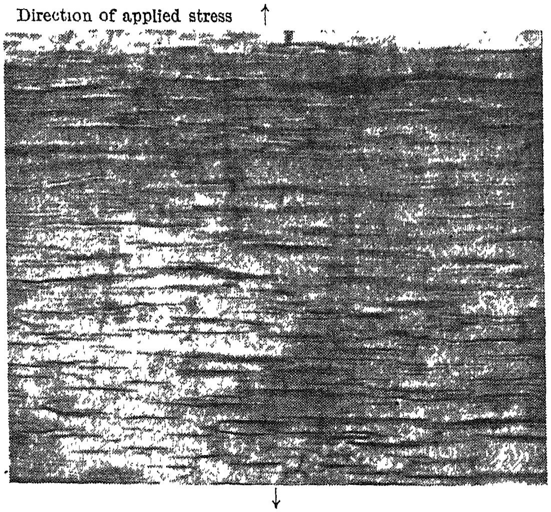

Fig. 2. Stress crazing (× 35)

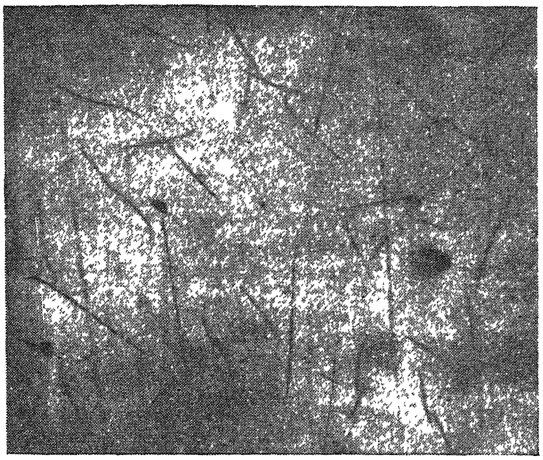

Fig. 3 Solvent crazing (× 35)

in removing stresses. For relatively high stresses the direction of the fissures is again perpendicular to that of the stress. For lower values a variety of patterns is observed as the two types of crazing are to a certain extent superimposed. A swollen polymer, even if it has not crazed during the absorption of solvent, exhibits very coarse cracks when stressed, a result essentially the same as when a plasticized polymer is stressed in the absence of other solvent.

Theory of Crazing

Some evidence has been given that, in crazing, actual cracking of the polymer surface occurs. Since a broken or cut surface does not show the effect in solvent vapour, the original cast surface and the zone beneath it must be a system containing all the factors necessary to crazing. It appears reasonable to assume that the fissures are produced by the same processes as are involved in normal tensile failure, and that the surface zone contains non-uniform randomly directed stresses which must have their origin in the past history of the material, that is, in the casting process.

Material polymerized below its ultimate second-order transition temperature contains molecular chains in a state of strain, and such material absorbs vapour more rapidly than that containing chains which are relaxed. Thus portions of the material become plasticized locally and incapable of supporting the proportions of the stress carried initially. This is thereby concentrated on to other stressed portions until the critical conditions for failure are reached. By a repetition of the process, local fissures are formed until the stress is relieved. The random distribution of the cracks observed in solvent crazing follows from the postulated random orientation of the stresses.

If an increasing uniform tensile stress is applied, the resultant stress within the surface is the sum of that stress and the component in the same direction of the internal one. Thus the critical conditions for fracture are attained locally before they are realized throughout the bulk of the material at ultimate failure. Only that component is now effective; and the cracks produced are perpendicular to it.

Rate of Solvent Absorption

From the postulated mechanism of crazing, a high rate of solvent absorption should be an important factor. Slow absorption should permit the relaxation of the surface stresses without sufficient local plasticization being reached to permit their concentration locally and the consequent failure of the more highly stressed material.

A sample of commercial polymethyl methacrylate sheet containing 8 per cent of dibutyl phthalate was heated to 35° C. in an evacuated system. Benzene was then introduced into the system and its vapour pressure was slowly increased by raising the temperature of the liquid in the coldest part of the apparatus from 0° C. to 27° C. during several days; absorption occurred slowly and without crazing. With a fresh sample of the same sheet the benzene temperature was rapidly raised by plunging the liquid into a thermostat at 27° C.; crazing was extensive within a few seconds. In the light of this result it is of interest to examine the conditions under which solvent absorption is rapid.

Baughan[9] observed marked hysteresis in the absorption of carbon tetrachloride by polystyrene; below a relative vapour pressure of 50 per cent no absorption could be detected. In the course of experiments on polymethyl methacrylate, similar effects have been observed for a number of systems. The accompanying table gives approximate values of the relative vapour pressure (p/p_0) of benzene necessary for appreciable absorption during one day by films held at 35° C.

Percentage dibutyl phthalate plasticizer	p/p_0 for 1 per cent absorption by weight
0	93
8·0	56
18·2	32

These figures show that the increased mobility of the polymer chains conferred by the plasticizer markedly lowers the resistance of the material to attack by moderate concentrations of vapour.

Stretching the heated polymer, followed by cooling to freeze in the deformation, greatly enhances the rate of absorption. This result is analogous to that considered by Flory[10] and Gee[11] on the swelling of stretched rubbers; greater swelling is to be anticipated, and the rate of swelling at any instant may be assumed to depend on the extent to which the sample can swell further. Fig. 4 illustrates the effect of stretching films at 140° C. on the absorption of acetone at 35° C. while a constant relative vapour pressure of acetone of 82·5 per cent is maintained.

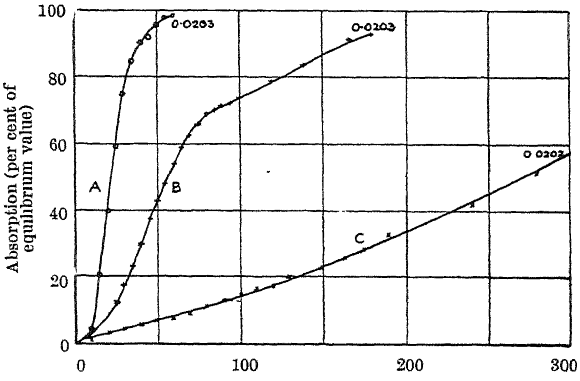

Fig. 4. Effect on absorption of acetone of stretching a methacrylate film. (*A*) 53 per cent unidirectional stretch; initial thickness, 0·0203 cm. (*B*) 22 per cent unidirectional stretch; initial thickness, 0·0203 cm. (*C*) Heated for 4 hr. at 140° C.; initial thickness, 0·0202 cm.

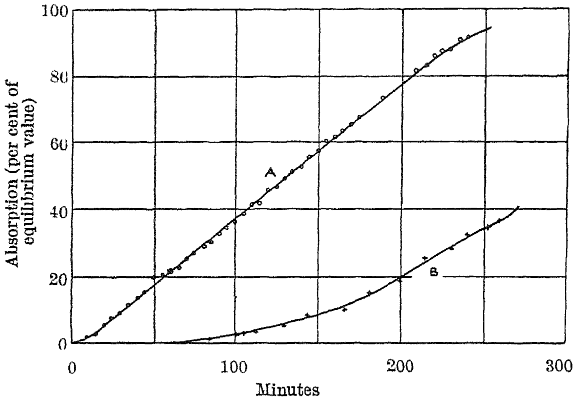

Fig. 5. Absorption of acetone by methacrylate before and after desorption. Initial thickness, 0·0236 cm. (*A*) Fully polymerized at 60° C. (*B*) Fully polymerized at 60° C.; desorbed and absorption repeated

With films which had been completely polymerized at 60° C. between glass by maintaining them at that temperature for at least four days, the absorption-rate (Fig. 5, curve *A*) greatly exceeded that of material heated at 140° C. (Fig. 4, curve *C*). Trommsdorf[12] found that, at 60° C. with 0·02 per cent benzoyl peroxide, polymerization was complete after 48 hours; the present samples contained 0·1 per cent peroxide and were heated for twice that period. After equilibrium was reached, solvent was removed by lowering the vapour pressure and raising the temperature. The original film weight was regained within 0·02 per cent. The absorption was then repeated (Fig. 5, curve *B*). By this method, initial film thicknesses and areas were constant, allowing a direct comparison to be made. The weight fraction of solvent in the film at equilibrium agreed in each case with that obtained under similar conditions with the pre-heated film. This, together with the fact that the original weight was obtained after desorption, is evidence that polymerization was complete, and the enhanced rate for the polymer cast at 60° C. between glass was not due to the presence of monomer. The similarity between the absorption curves for stretched films and for those polymerized at 60° C. suggested that the latter are effectively in a state of tension, and that the effect of heating or of solvent absorption is to permit relaxation. Even after several hours of heating at 140° C. in a deformed state, recovery is nearly complete if the deforming stress is removed and the temperature raised a few degrees. Thus chain entanglements limit the viscous flow of chains over one another and the relaxation of highly elastic strains to free portions. On absorption of sufficient solvent, however, chains are separated and allowed to assume a random configuration, and they retain this on desorption. In agreement with this theory it is observed that films heated for 4 hr. at 140° C. showed immediate absorption (Fig. 4, curve *C*), whereas comparable desorbed films showed a pronounced delay before absorption commenced (Fig. 5, curve *B*). That the condition of polymerization in contact with the glass surface is not responsible for the large difference in absorption-rates before and after relaxation is shown by the fact that similar differences were observed in a film completely polymerized on mercury.

Summarizing, plasticized polymethyl methacrylate is more susceptible to attack by moderate concentrations of vapour than is the unplasticized material. The rate of absorption is enhanced by the presence of frozen-in strains of the highly elastic type such as occur at points of high curvature in articles formed from sheet material at elevated temperatures.

Polymer stretched at ordinary temperatures by external stressing alone should absorb solvent at an enhanced rate. From the law of mobile equilibrium, the effect of the strain is to increase the swelling to counteract it, and we may assume as before that the rate of swelling depends on the extent to which the sample can swell further. This can be shown as follows: a sample was selected which when exposed to volatile solvent did not craze even on subsequent stressing. However, on maintaining the stress while applying the solvent, crazing was instantaneous. Within the time of exposure when unstressed, absorption was inappreciable; when stressed, the rate became rapid.

Relation of Second-order Transitions to Crazing Phenomena

The observation that heat-treated methacrylate is less susceptible to solvent crazing suggested that, in addition to the effect of completing polymerization, surface stresses initially present are removed. It was anticipated that heating just above the second-order transition temperature for a short time would remove such stresses; more prolonged heating was required to complete polymerization, as was shown by shrinkage-time measurements.

Samples of commercial material containing 8 per cent plasticizer and 3·3 per cent of residual monomer were exposed to benzene vapour at room temperature after heating each for 2 hr. at one of a range of temperatures. At 40° C. no alteration in crazing occurred; at 50° C. it was somewhat reduced, and at 55° C. became very slight. At 60° C. none was observed; but less than half of the residual monomer was polymerized. For this material the transition temperature initially was 51° C., rising with the disappearance of monomer to 78° C. As a matter of interest, a transition point between 50° and 60° C. was predicted from these results before the determinations were made by the usual dilatometric method. It was concluded from these experiments that stress as postulated is a necessary condition for solvent crazing. There is no evidence that monomer is essential to the crazing mechanism. A fully polymerized material when sufficiently stressed will absorb solvent, and crazing appears.

The critical conditions for failure under external stress could conceivably be attained by stress concentration at local surface defects, such as are considered to initiate the failure of crystals and of glasses. Consideration of the local conditions when a uniform tensile stress alone is imposed shows that any local failure started in this manner should be self-propagating to result in complete rupture, inasmuch as such failure produces increased concentrations of stress. It is therefore improbable that such defects are the sole cause of local failures distributed over a surface. Since the non-uniform surface stresses regarded as necessary for crazing under externally applied stress are relaxed at the second-order transition point, this should represent an upper temperature limit for the effect to occur. Completely polymerized methacrylate samples were heated and rapidly stressed at a range of temperatures; no crazing was observed above the second-order transition point, although it could be produced below that temperature.

Elastic Deformation in Relation to Crazing

Many authors have considered a general deformation of a polymer as the sum of a number of separate components of differing mechanism. The total response to stress is composed[13] of instantaneous elasticity, retarded configurational elasticity and flow. The instantaneous 'ordinary' elastic component results from the separation of molecular chains and the deformation of molecules by changing the normal valency angles between the bonds and/or the bond-lengths. The highly elastic deformation arises from changes in the shape of the molecules by a time-dependent re-orientation of the chains, and the time-dependent flow results from the irreversible slipping of chains along one another altering their relative positions; in the case of polymethyl methacrylate, this is negligible at room temperatures. Also, at this temperature, unplasticized methacrylate is about 80° C. below the transition temperature, so that the highly elastic factor is not predominant in the short time occupied by a normal laboratory tensile test. Thus under these conditions the major deformation leading to fracture must result from the 'ordinary' elastic component. Hence it is concluded that crazing is induced by the presence within the material of 'ordinary' elastic strains resulting from the stresses already considered. Alfrey[13] defines as true internal stresses those in which "one part of the object pulls or pushes against another part and because of the geometry of the system these forces cannot be relieved". Frozen-in highly elastic strains experimentally give no indications of crazing. Alfrey points out that in these cases the internal stress commonly referred to does not have the physical significance of a true stress. Samples recover their original shape on heating because the internal Brownian movement produced brings them to the most probable condition.

Meyer[14] discusses the rupture of polymers and considers the effects of breaking the molecular chains and of slipping of the chains over each other. In the latter, intermolecular forces are overcome, and irreversible deformation leads to necking and ultimately to breakage and is favoured by a slow rise in tension. With very high molecular-weight polymers such as cast polymethyl methacrylate (molecular weight $\simeq 1\text{–}2 \times 10^6$) long portions of the chains have to slide over each other for failure, and it becomes easier to rupture primary bonds than to overcome the increased intermolecular forces. A rapid rise in tension favours chain rupture. These considerations agree with the above conclusion that primary-bond deformation is produced in the methacrylate sheet.

Molecular Orientation and Crazing

In a recent paper, Sauer, Marin and Hsiao[15] have suggested that crazing is essentially an orientation phenomenon and not one of mechanical crack formation. The latter, on this theory, is only an associated phenomenon if the applied stresses are high enough to produce fracture. X-ray diffraction results are adduced as evidence for orientation in the direction of stretching of crazed polystyrene. Unstretched material is considered to exhibit random orientation of geometrically ordered regions in the otherwise amorphous structure. These authors used polarized light to detect residual stresses in their material, rejecting those sheets showing evidence of such internal stresses. They concluded that crazing occurs where no appreciable residual stresses are present.

Considering the above evidence, it is seen that X-ray diffraction detects orientation which is not detected by polarized light. Particles which are optically anisotropic may be too fine to show appreciable retardation individually according to Chamot and Mason[16]. Moreover, the effects of local tensile stresses and the equivalent compressive stresses tend to cancel each other. Inasmuch as random orientation is evidence of the effect of randomly directed forces, the theory that the latter are responsible for crazing does not appear to be invalidated.

The suggestion that the visual effect observed in crazing is due to orientation alone requires further examination. No change in transparency of sheet material is observed on hot stretching, when more orientation is to be anticipated than in a tensile or creep test, and such material is not susceptible to crazing. Also, for all the cases examined the haze observed is resolved under high magnifications into a pattern similar to the more obvious cracks visible at low magnifications. It is concluded that crazing and orientation are both effects of tensile forces but are not identical.

Observations on Fracture

Experimentally, the conditions for fracture are attained locally in the surface before failure of the bulk of the material. Crazing is produced at a stress considerably lower than the ultimate strength, and there is evidence that for a given sheet at each temperature this is a more or less constant proportion of the load at fracture.

The reverse bending of a specimen already crazed under bending caused the disappearance of the visible effect. In this connexion Haward's[17] results on cellulose acetate are of interest. He showed that extension produced a whiteness and opacity which he attributed to hole formation. Extension of the material under a load, applied for a time insufficient to break it, permanently weakened the material even after the deformation was removed by heat. Re-application of the load produced early failure, and the total time of application was approximately constant independently of how it was subdivided. In methacrylate the healing of cracks by the entanglement of molecular chains when two surfaces are mechanically pressed together is improbable, and a similar weakening is to be anticipated though visible crazing has disappeared. This was shown by the following experiment: a sample was crazed by bending; on removal of the stress the sample was heated at 100° C. until all traces of crazing disappeared and was then allowed to cool. On re-stressing, crazing was rapid; if the original pattern was produced in a characteristic shape by wiping the stressed sample with volatile solvent, the same shape was re-formed.

Origin of Surface Stresses in Cast Sheet

It has been shown that the stresses remaining in commercial methacrylate sheet to produce crazing must arise at some stage of the casting process. The sheet is produced by completing the bulk polymerization of partially polymerized syrup in glass cells at a slightly elevated temperature. Since, in order to sustain a stress, a high extent of polymerization is necessary, only the later stages of the process need be considered. A possible cause of tensile stresses near the skin can now be advanced.

The polymerization reaction is highly exothermic, and unless adequate heat transfer occurs, the temperature of the reacting mass may rise considerably above that of the surroundings. The thermal conductivity of the polymer is insufficient to maintain a uniform temperature throughout the sample, and the centre is therefore at a higher temperature than the polymer – glass interface. Hence, until polymerization is complete, the extent of conversion is greater in the bulk of the material than at the surface. The reaction proceeds with considerable shrinkage (about 26 per cent for methyl methacrylate), so that greater shrinkage occurs within the material than in the outer portions. So long as sufficient monomer remains in these latter zones to permit chain mobility, no stresses are produced. Further reaction shrinks this shell on to the inner more fully polymerized material, compressing the latter and leaving the surface in tension.

Tensile stresses do not remain in the material if it is heated above the second-order transition temperature. Irregular cooling of the material from above this temperature gives rise to density gradients throughout the mass. Since the surface cools more rapidly than the bulk, the density of the latter is the greater; compressive stresses in the surface result, and these do not produce crazing. Such material should, in fact, be craze-resistant, as is the case with properly heat-treated material. Tensile test specimens, appropriately heat-treated after preparation, failed under normal rates of loading without crazing even in the form of haze. Non-uniform stressing, for example, in bending, readily produced crazing on heat-treated specimens.

It has been shown that the stresses may be removed from an incompletely polymerized sample by heating. When now the same material was heated at 60° C. for a prolonged period so as to complete the polymerization at a temperature below the ultimate second-order transition point, crazing could once more be produced by the application of solvent. Similarly, heat-treated polymer, which did not craze with the solvent, could be caused to craze under those conditions after polymerizing the monomer which it was allowed to absorb by immersion. This is attributed to the re-introduction of tension into the surface by polymerization shrinkage. Such further polymerization with the production of the stresses needed for crazing may occur under suitable conditions of prolonged storage.

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MORPHOGENESIS IN PLANTS AND ANIMALS

At a meeting of the Linnean Society on November 24, under the presidency of Prof. F. E. Fritsch, Profs. Eric Ashby and C. W. Wardlaw, of the University of Manchester, gave an account of experimental investigations which they have been conducting on morphogenetic processes in plants, while Prof. G. R. de Beer, of University College, London, contributed a commentary on comparable phenomena in animals.

The discussion opened with a paper by Prof. Ashby and Miss E. Wangermann on morphogenesis in *Lemna minor*. The aim of the work described was to study by quantitative methods the rate of ageing of a plant grown under controlled conditions. *Lemna* was selected for the work because it can be grown conveniently in the laboratory and because a frond has a finite expectation of life (about forty days) during which it produces a finite number of daughter fronds (some five or six). There is a decrease in size from one daughter frond to the next, so that a fourth daughter frond, for example, is only one-fifth as large as a first daughter frond. This decrease in size is used as a measure of the rate of ageing. Factors (such as the presence of 2·5 mgm. per litre of heteroauxin), which shorten the expectation of life of a mother frond, at the same time increase the rate of diminution of size from one daughter frond to the next; and the rate of diminution of size between daughters corresponds to the rate of ageing of the mother.

In order to determine the cause of the decrease in size of successive daughter fronds as the mother frond becomes older, Prof. Ashby and Miss Wangermann carried out experiments designed to test whether (*a*) the mother frond produces a growth-promoting substance which diminishes in concentration as the frond ages, or (*b*) the mother frond produces a growth-inhibiting substance which increases with its age. The experiments demonstrate that the mother frond promotes, and does not inhibit, the growth of its daughters. If all but a fifth of the mother frond is cut away, the daughter fronds still receive enough of the growth-promoting substance to enable them to grow almost to their normal size. Preliminary experiments indicate that the growth-promoting substance is not heteroauxin.

Prof. Wardlaw illustrated the structure of large apices of ferns such as *Dryopteris aristata*, and pointed out that the leaf primordia, which constitute a very regular phyllotactic sequence, are widely spaced around the base of the apical cone or growing point. Bud positions may be described as axillary or interfoliar. In studies of morphogenesis some explanation is needed of the curious fact that whereas leaf primordia are formed, bud primordia are not, although the rudiments of both are histologically identical and both occupy comparable positions *vis-à-vis* the shoot apex. With modifications, the hypotheses of Schoute (1913) afford a means of accounting for the development of a phyllotactic sequence, the inhibition of buds and the regulated or harmonious development of the leafy shoot. The hypotheses now advanced by Prof. Wardlaw are that the shoot apex and each young leaf primordium are a growth-centre around which a physiological field develops; and that a new growth-centre cannot arise within an existing field but can arise on the apical meristem outside it, that is, fields have inhibitive properties. It is assumed that there is no fundamental metabolic difference between shoot and leaf apices.

These ideas are now supported by a considerable body of experimental evidence which was illustrated in the lecture. Thus it was shown that a leaf primordium, or a primordium site, which is isolated from the adjacent, older primordia by vertical incisions, shows rapid relative growth and soon develops to large size. Reference was made to the work of Mr. and Mrs. Snow, who have shown by experimental means that in flowering plants the next leaf primordium to be formed arises in the 'next available space' on the meristem above the top cycle of primordia. Experimental studies have shown that this also holds good for the ferns. In them, also, the next primordium to be formed arises in the widest available space, yet only occupies a small part of it.

The explanation now advanced is that the space needed for the inception of a primordium must be wide enough so as not to be completely eclipsed by the inhibitive fields of the two adjacent primordia, though the area needed for the actual primordium site may be quite small. In other experiments Prof. Wardlaw showed that the inhibition of buds at the apex is due to the adjacent leaf primordia and that, by appropriate but simple techniques, buds can be induced to arise in what are normally leaf positions and leaves in bud positions. Indeed, it seems that very little is needed to tip the balance between leaf formation and bud formation at the fern apex. The whole of the fern apex is thus totipotent in respect of the formation of its lateral members, and the characteristic symmetry and structure of leaves and buds are due to the positions in which they are formed and to the factors of growth and related factors which are incident in these positions.

Prof. de Beer, referring to the work of Mr. and Mrs. R. Snow and of Prof. Wardlaw on correlation and phyllotaxis, stated how impressed he had been by the many parallelisms between the problems of experimental embryology in plants and animals. He then proceeded to illustrate evidence of the power possessed by certain regions of the animal body to control or suppress the appearance of other structures within a certain distance, citing the control of pharynx development in planarians: the distance of the pharynx behind the head being a function of the degree of development of the head itself. A further example of the power of inhibiting at a distance has been shown by work on the cœlenterate *Cordylophora*. When fragments of this organism are allowed to aggregate, the mass normally gives off a number of outgrowths, each of which regenerates into a polyp. But if to the aggregated mass there is added an oral cone of another individual, not only does the oral cone induce the formation of a polyp immediately beneath itself, but also it inhibits the formation of other outgrowths and polyps.

At this point Prof. de Beer emphasized that these close parallelisms between phenomena in plants and animals would repay further attention. Field phenomena, as exhibited by the apices of plants, can be matched by many examples from animals. In particular, the modification of a leaf position on the meristem by experimental means is closely comparable with data which have been obtained on limb formation in amphibians. Within the limb-disk, at an early stage, there is still an indeterminacy as regards the precise location of the future arm or arms: the only thing that is determined is that if anything is developed at all, it will have the quality of an arm. This state of indeterminacy within an area which already possesses a general determination as regards its fate is usually described by saying that the rudiment represents a morphogenetic field: within that field the power of regulation is still present. The properties of morphogenetic fields were illustrated by reference to Prof. Murray's experiments on the limb-bud of chicks. When the limb-disk has grown out into a conical bud, a regional determination into subfields apparently takes place, for, when isolated, the proximal half, in the case of a leg, develops into a complete and nearly perfect thigh, without any shank, while the distal half of the same bud can give rise to a perfect foot and shank. Within the sub-fields, regulation takes place by means of the formation of the structure characteristic of that sub-field and the suppression of others.

By reference to these and other examples, Prof. de Beer showed how the discoveries already made by experimental embryologists may shed light on some of the problems that are now engaging the attention of botanists interested in morphogenesis.

OBITUARIES

Mr. H. H. Cousins

HERBERT HENRY COUSINS, son of the Rev. W. E. Cousins, was one of the group of young scientific workers who, in the mid-eighteen-nineties, took their courage in their hands and boldly turned over to agriculture, taking advantage of the means provided by Mr. Goschen's tax on whisky, put on in 1890, the proceeds of which might be utilized by a county for advancing agricultural education. The counties of Kent and Surrey early decided to do this, and under the guidance of A. D. Hall in 1894 established an agricultural college at Wye in East Kent. From the outset, Hall took the view that his colleagues must first and foremost be thoroughly expert in the pure science which they professed; he knew that agricultural knowledge could be added at Wye, but nothing could make good any weakness in the scientific foundations. Cousins was appointed chemist. He had had a good career in pure chemistry. He was a postmaster of Merton College, Oxford, and in 1889 he gained a first-class in natural science; he studied later at Heidelberg, then the Mecca of young chemists from Great Britain. He returned to Oxford for a time as demonstrator in the chemical laboratories, and took an active part in the University extension lecture scheme, then very popular.

In 1894 Cousins went to Wye and immediately began studying the practical problems of agriculture and gardening. He took a house with a large garden on Church Green and then began to grow plants, subject always to the criticisms of the very expert village workers, acquiring the full knowledge of this subject that he afterwards set out in a delightful little book, "Chemistry of the Garden". He was obviously much influenced by Georges Ville and Sir William Crookes, and under-estimated the role of organic manures; had he revised the book when he retired and had some leisure, it might still have been a standard treatise. He was also interested in pigeons. In the laboratory he made pioneering studies of hop resins, washes and other practical problems, and he translated into very readable English Kellner's text-book on animal nutrition, then the leading German treatise on the subject.

Short in stature, but full of courage, outspoken and very deliberate of speech, capable of vaulting over any fence or gate that he could see over, he won the respect of the students but was too reserved to make friends among them. His wife, Minnie, daughter of Mr. R. J. Hardy, and their three children, two daughters, one of whom died in 1926, and a son, made the home an attractive place for those privileged to visit it.

In 1900 Cousins accepted the post of island chemist, Jamaica, where one of his various duties was to overhaul the manufacture of rum. He so impressed the authorities that in 1908 he was appointed director of agriculture, a post which he held until 1932. He had already in 1907 been appointed a member of the Legislative Council and retained his seat until 1923; his profound knowledge of the island and of its possibilities marked him out as the obvious chairman of the commission to inquire into the distressed districts.

Cousins concentrated his attention on the island problems and made little contribution to the various controversies in agricultural science that developed during the first thirty years of this century; his records are found in his official reports and in the Jamaica Herd Book. He never lost his gift of lucid writing, however, as shown by his "History of Hope Farm".

He retired from the directorship in 1932 and in due course settled in Oxford where, through failing health, he lived in quiet retirement, taking no part in the numerous agricultural activities there going on; the younger generation, therefore, had little opportunity of getting to know him. This was a pity, for he was a man of full knowledge and ripe experience of the type of problems now daily assuming more and more importance.

E. JOHN RUSSELL

Mr. E. G. Baker

EDMUND GILBERT BAKER died at his home at Kew on December 17, at the age of eighty-five. He was the only son of John Gilbert Baker, the well-known Yorkshire botanist, who in 1866 became first assistant in and later (1890–99) keeper of the Herbarium, Royal Botanic Gardens, Kew. E. G. Baker was born at Thirsk, Yorkshire, on February 9, 1864, and received his education at Bootham School, York, and the Pharmaceutical College, London. For some time after serving an apprenticeship as a pharmacist at Chertsey he remained connected with pharmacy, and was awarded the Pereira Medal by the Pharmaceutical Society in 1886. His interest in botany was, however, already evident, and in 1887 he was appointed to a junior assistantship in the Department of Botany at the British Museum (Natural History). He was elected a fellow of the Linnean Society in the same year and served on the Council during 1917–21. He retired from the staff of the British Museum in 1924, but continued to work in the Department of Botany for many years after his official retirement and was designated honorary assistant keeper.

E. G. Baker was a taxonomist of the old school. He was for a long period in charge of the Polypetalæ at the Museum and was responsible for the working out of the members of this group in many important collections received during the period he was assistant. Papers by him, often in association with colleagues, were published in the *Journal of Botany*, the *Journal of the Linnean Society*, and elsewhere. He wrote an important paper on the African species of *Crotalaria* (*J. Linn. Soc.*, 42, 241; 1914). When he became independent of official duties he concentrated on African Leguminosæ and published his most important work, "The Leguminosæ of Tropical Africa", in three parts, 953 pages in all (Ghent, 1926; Ostend, 1929; Ostend, 1930). This contains generic descriptions and keys and short descriptions to the species and varieties of members of the family from tropical Africa.

E. G. Baker was closely associated with the Society of Friends and served with one of their ambulance units in the First World War. He was never married and his only sister predeceased him.

W. B. TURRILL

Mrs. Evershed

WE regret to record the death of Mary Acworth Evershed, at her home in Ewhurst on October 25. She was the fifth child of Captain Orr, R.A., and Mrs. Orr, and was born at Plymouth on January 1, 1867. Her father died when she was three years old, and her mother and family then went to live in the vicarage of South Stoke, near Bath, of which parish Mrs. Orr's father was vicar.

Even in her early days she displayed an interest in astronomy—an interest which was destined to ripen in later years into important work in this branch of science. When she was about twenty years old she went abroad, studying Italian and German and also art; afterwards she spent several years in Australia (1889–95). There she met Mr. Tebbutt, of the Observatory of Windsor, N.S.W., from whom she received a considerable amount of encouragement in her astronomical studies, and who wrote a preface to her first work, "Southern Stars".

The year following her return to England in 1895 she joined the British Astronomical Association, and went on the B.A.A. Eclipse Expeditions to Norway in 1896 and to Algiers in 1900. Arrangements were made for her to work at Dunsink Observatory in 1905, when Prof. (now Sir Edmund) Whittaker was at the University of Dublin; but the scheme did not materialize owing to her marriage in 1906 to Mr. John Evershed. When he went to Kodaikanal Observatory, India, she accompanied him, travelling by way of the United States and Japan, and visiting a number of observatories on the journey. During her stay in India she published her work, "Dante and the Early Astronomers", in 1913, and two years later her book "Stars of the Southern Skies" appeared.

Mrs. Evershed did important solar work at the Kodaikanal Observatory and contributed a memoir on prominences and also a paper in the *Monthly Notices of the Royal Astronomical Society* (73, 422; 1913). She was elected a fellow of the Society in 1923, serving for a time on the Library Committee, and was also a member of the Astronomical Society of the Pacific. In 1930 she was appointed the first director of the newly formed Historical Section of the British Astronomical Association—a position which she held for fourteen years, and in which she did very valuable work. Members will remember her unfailing courtesy and prompt attention to queries relating to the historical side of astronomy.

NEWS and VIEWS

Institution of Electrical Engineers Awards

THE Council of the Institution of Electrical Engineers has elected Prof. E. W. Marchant to be an honorary member of the Institution in recognition of his services to the Institution and for the outstanding contributions he has made to the advancement of electrical knowledge.

The Faraday Medal of the Institution has been awarded to Sir James Chadwick, for his contributions to science generally and more particularly for his distinguished work in nuclear physics.

Prof. E. W. Marchant

PROF. MARCHANT is a past-president of the Institution and has given long and distinguished service on the Council. He is now emeritus professor of electrical engineering in the University of Liverpool. At an early stage in his career, Prof. Marchant worked with W. Duddell on the development of the bifilar oscillograph and with Lord Blythswood on the absorption of X-rays by aqueous solutions of metallic salts, establishing the dependence of this absorption of the solution on the atomic content. In 1900 he made experimental tests on the oscillatory discharge of condensers, from which the ohmic resistances of spark discharge carrying currents up to 2,000 amp. were estimated. He became senior lecturer under Silvanus Thompson at Finsbury Technical College and in 1901 went to University College, Liverpool. When in 1903 the College achieved university status, Prof. Marchant was appointed to the David Jardine chair of electrical engineering, which he held until his retirement in 1941. He devised equipment for the accurate measurement of the strength of radio signals, and also designed a new high-voltage laboratory for the impulse testing of high-voltage cables which was opened in 1940. Prof. Marchant's long association with the Institution commenced in 1898 when he was elected an associate.

Sir James Chadwick, F.R.S.

SIR JAMES CHADWICK collaborated in the 'twenties with Lord Rutherford in research work at the Cavendish Laboratory; the fundamental researches they then conducted laid the foundations on which the structure of modern nuclear physics rests. In 1935 he went to the University of Liverpool, where he was Lyon Jones professor of physics until 1948, when he returned to Cambridge as master of Caius College (see *Nature*, 161, 964; 1948). For his work in investigating α-, β- and γ-rays, and particularly for his discovery in 1932 of the neutron, Sir James was in that year awarded the Hughes Medal of the Royal Society; this last-named discovery was further recognized in 1935 when he received the Nobel Prize for Physics. His services during the Second World War in connexion with the developments in the use and control of nuclear energy were honoured in America when he was awarded the United States Medal of Merit. He was knighted in 1945.

International Exchange of Students for Technical Experience

THE second annual report of the International Association for the Exchange of Students for Technical Experience (Pp. 28. London: J. Newby, General Secretary, Imperial College of Science and Technology, 1949) covers the period January–October 1949, inclusive. The numbers exchanged increased from 920 in 1948 to 1,236, and of these Great Britain supplied 285, Finland 171, Netherlands 140, Sweden 137, France 132, Denmark 89, Norway 88, Switzerland 80, Austria 68 and Belgium 46. Great Britain received 314 of these students, Sweden 288, France and the Netherlands 123 each, Norway 86, Switzerland 85, Denmark 73, Austria 53, Finland 49 and Belgium 42. During the summer vacation of 1949 the students were distributed in almost every branch of industry, but mechanical (408), electrical (216), chemical (187) and civil engineering (182) claimed by far the greater number, mining (75) and chemistry (44), which came next, being far behind. In some countries the industrial distribution was better balanced, but in others it should be possible to provide a wider range of industrial experience for students of science and technology. In September the Association was approved by the executive board of the United Nations Educational, Scientific and Cultural Organisation for consultative arrangements. The Brussels Treaty Permanent Commission appointed a liaison officer between the Association and its cultural committee, and the exchanges made by the Association were highly praised by the mixed commission under the Cultural Convention between the United Kingdom and Norway at its meeting at Edinburgh in June. Austria participated for the first time in 1949, and it is hoped that Italian students will participate fully in the 1950 exchanges. Details are given in the report of the participating institutions and firms; in Great Britain students from the Universities of Cambridge, Durham, Oxford, Birmingham, Bristol, Edinburgh, Glasgow and London, the Manchester College of Technology and the School of Metalliferous Mining (Cornwall) participated. Reports on work by foreign students visiting Great Britain show a keen appreciation of the facilities provided.

Science and International Relations

THE fifteenth Robert Boyle Lecture delivered by Dr. J. Needham before the Oxford University Scientific Club on June 1, 1948, on "Science and International Relations" (pp. 30. Oxford: Blackwell's Scientific Publications, 1949; 2*s*. 6*d*.), has now been published. Dr. Needham devotes the first part of his lecture to a brief but lucid survey of the international unions and their inter-relations as well as of their relations with Unesco, before proceeding through a survey of international government scientific organisations of the scientific liaison offices, and of the United Nations Organisation and its specialized agencies to outline the origin and structure of Unesco. In the course of this useful survey Dr. Needham notes that the International Bureau of Physico-Chemical Standards is enlarging its work by a grant from Unesco and accumulating samples of chemicals which are rare or unobtainable in commerce. Among new unions in process of formation are the International Union of Nutritional Sciences, the International Union of Ethnology, Pre-History and Anthropology, the International Union for the Preservation of Nature, and possibly an International Union or Council of Agricultural Sciences.

Much of the value of Dr. Needham's lecture lies in the clear picture he gives of these inter-relations, but he concludes with a most opportune survey of the scientific programme and achievements of Unesco in which, emphasizing the necessity in international intercourse for the point of view of the man of science, he pleads for an end to parochialism among scientific men themselves. They must play their part in the relations of their own country with other countries whether by meetings or travels on scientific business, by means of work in their own foreign services, or in international organisations under the United Nations in which may be brought together scientific workers from every people and every land. Dr. Needham includes in his lecture warm tributes to the work of Dr. Julian Huxley and of Dr. J. T. Bodet, who has succeeded the former as director-general of Unesco.

Technical Co-operation in Africa

REPRESENTATIVES of the Belgian, French, Portuguese, South African, Southern Rhodesian and United Kingdom Governments held a Conference in Paris during January 11–14 to continue the work on technical co-operation in Africa south of the Sahara which has been going on during the past five years. The first in this series of meetings was held in 1945 between the French and British Governments and concerned itself with West Africa, when questions of public health were examined. Since that time technical co-operation has been extended to other subjects and now includes Belgium, Portugal, South Africa and Southern Rhodesia and their dependent territories. Resulting from the Conference just held in Paris, it has been agreed to recommend the establishment of a Commission for Co-operation in Technical Matters in Africa south of the Sahara. This Commission, which will meet twice a year, will have an administrative role and have among its objects that of giving practical effect to technical co-operation in Africa. The Conference also recommended that the existing practice should be maintained whereby observers from the specialized agencies of the United Nations or E.C.A. are invited to be present at its technical conferences. The Conference also agreed to the establishment of a secretariat with its seat in London, which would have the task of: (*a*) reviewing and co-ordinating the programmes of technical co-operation in Africa south of the Sahara, including follow-up action for dealing with rinderpest, sleeping sickness, soil conservation, anti-locust campaigns, etc.; (*b*) drawing up and submitting to the Member Governments plans for further programmes of technical co-operation; (*c*) seeking the approval of governments for recommendations made at recent conferences, such as the transport conference at Lisbon, scientific conference at Johannesburg, nutrition conference at Dchang, French Cameroons, and indigenous rural economy conference at Jos, Nigeria.

A Systemic Insecticide in Commercial Production

ONE of the most striking of recent developments in insecticides has been the discovery in Germany of the toxic properties of a long series of organic phosphorus compounds. Some of these compounds have the property of being absorbed by the roots or leaves of plants and being translocated to other parts, so killing all the aphids and other sucking insects which feed upon them. One of these compounds, *bis* (*bis*-dimethylamino)-phosphonous anhydride (see *Nature*, May 21, 1949, p. 787, and September 24, 1949, p. 522), has been selected by Pest Control, Ltd., of Cambridge, and with remarkable speed has now been developed and made available commercially under the name of 'Pestox 3'. The great virtue claimed for this material is that while it is highly toxic to greenfly and to red spider mites, it is without effect on ladybirds, parasitic Hymenoptera, and other enemies of these pests. There is some disagreement in the published reports upon the extent to which this material is absorbed and translocated after application to the leaves of plants; but there can be no question about its great effectiveness in practical use. The chief problem raised by the widespread use of this systemic insecticide is one of toxicity to man. This will not arise when it is used on roses or chrysanthemums—except that the greatest care is needed on the part of those who have to handle and apply the insecticide. But where it is used on crops for human consumption, it is highly dangerous to apply it later than one month to six weeks before marketing. This places a heavy responsibility on the grower.

New Insect-proof Material for Packaging

A NEW insect-proof packaging material which is cheap and very easy to handle has been developed by the Pest Infestation Laboratory of the Department of Scientific and Industrial Research. There is considerable wastage in packaged foods, resulting from the penetration of insects from outside. It was found that a layer of sand-paper formed an effective barrier, but did not prove practicable in use. Paper and corrugated cardboard impregnated with D.D.T. were unsuccessful because the insects bored straight through and so did not remain long enough in contact with the insecticide to pick up a lethal dose. The final solution was to use cellulose wadding, several layers thick, impregnated with D.D.T. When faced with this material the insect, after getting through the first layer, wanders in all directions and so takes up enough D.D.T. to be killed. Not one insect has ever got through this material in the course of numerous laboratory tests. The material is bulky and therefore suited to covering groups of packages rather than small containers. Provided there is a fairly large overlap, the wadding need not be sealed round the package; it will be sandwiched between layers of ordinary paper to prevent contamination of the goods by D.D.T. This packing material is due for testing on a commercial scale shortly.

Northern Advisory Council for Further Education

IN the second year of its existence the Northern Advisory Council for Further Education had before it the dual task of building up its organisation and of carrying out the advisory duties laid upon it during its year of inauguration. An interlocking regional plan for technical, commercial and art education has been produced and issued to local education authorities in the area for information and guidance in preparing their own development schemes. Surveys have also been made of the educational requirements of a number of industries, and a regional scheme formulated for courses of training for part-time and intending part-time teachers. Contact with the industry of the region has been broadened by the establishment of permanent advisory committees for the important building and engineering industries. Copies of this interesting report showing how technical education is being integrated on a regional level may be obtained from the Secretary, 43 Eldon Place, Barrasbridge, Newcastle upon Tyne, 1.

Earthquakes Registered in New Zealand

DURING the second quarter of 1949, thirty-eight strong and thirty-eight minor shocks were registered on the seismographs in New Zealand. Of these, at least ten of the strong shocks and all the minor ones were local. The greatest of these local shocks had instrumental magnitude 6¼ and was felt with intensity 6 on the Modified Mercalli scale in the southern part of South Island. It occurred on May 27 at 8h. 54·1m., G.M.T., and the epicentre was near lat. 45·5° S., long. 167° E. Three local earthquakes also attained instrumental magnitude 5¾. These were on April 9 (epicentre 36½° S., 178° W.), May 29 (epicentre 39·7° S., 174·2° E.) and June 27 (epicentre 37·55° S., 177·05° E.).

Smith–Mundt Grants for Study in the United States

Under Public Law No. 402, Eightieth Congress (Smith–Mundt Act), a limited number of dollar grants from the United States Government are available to university teaching staff or those of equivalent academic status in other institutions and to senior research workers who wish to visit the United States for the purpose of study, research or lecturing. Candidates must be affiliated with an American institution of higher learning; research workers must spend at least three months in the United States, and visiting lecturers at least six months or one semester; all applicants must be citizens of the United Kingdom. Successful candidates will also be awarded a Fulbright grant to cover travel from Great Britain to the United States and return. The maximum grant under the Smith–Mundt Act is 2,000 dollars a year, plus the cost of internal travel within the United States (when not covered by the Fulbright grant), plus an allowance of 10 dollars a day during this travel. The grants will operate for twelve months from June 1. Prospective candidates should write immediately to the United States Educational Commission in the United Kingdom, 55 Upper Brook Street, London, W.1, for the application forms, which must be returned before February 18.

Scientific Film Shows at the Science Museum

In order to familiarize a wider public with the increasing use of scientific films, both as a means of research itself and as a means of disseminating scientific information, special film shows will be held on the third Saturday of every month in the lecture theatre of the Science Museum at South Kensington. These shows have been arranged by the Scientific Film Association and will take place at 10.45 a.m. Admission is free. At the opening meeting, on January 21, two films will be shown: "Ermites du Ciel", a French film describing the life, conditions and equipment at the Pic du Midi Observatory in the Pyrenees, and "Heating Research in Houses", produced by the Building Research Station.

Third World Petroleum Congress

The Third World Petroleum Congress will be held at The Hague, Holland, during May 28–June 6, 1951. The main headings under which papers will be presented and discussed are: (1) geology and geophysics; (2) drilling and production; (3) refining technology—(*a*) physico-chemical methods, (*b*) methods involving change in composition; (4) petrochemicals; (5) analysis and testing; (6) utilization of products; (7) plant and equipment; (8) transport, storage and distribution; (9) economics and statistics. The various sessions will be held in hotels in The Hague, and the information office will open in the Kurhaus Hotel on May 28, 1951. Excursions to petroleum and industrial centres and to places of interest will be arranged, and social events for the evenings will be organised. The Permanent Council of the World Petroleum Congress has requested the appropriate body in each country to form a national committee which will be responsible for organising the collection of papers within its own country. For Great Britain, the Institute of Petroleum has been invited to form the national committee, and this consists of: E. A. Evans, Lieut.-Colonel S. J. M. Auld, C. Chilvers, T. Dewhurst, Prof. F. H. Garner, H. S. Gibson, H. Hyams, G. Sell, C. A. P. Southwell, H. C. Tett. Further details can be obtained from the Secretary of the Third World Petroleum Congress, Carel Van Bylandtlaan 30, Den Haag, Holland.

"Low-Frequency Components of Atmospheric Pulses and their Origin"

Referring to the communication by Prof. S. R. Khastgir and R. Roy in *Nature* of September 17, p. 488, under this title, Mr. C. E. R. Bruce, of the Electrical Research Association, 5 Wadsworth Road, Greenford, Middlesex, points out that he gave a similar and quantitative explanation of the effect in *Nature*, 148, 165 (1941). This communication had been overlooked by Prof. Khastgir.

Announcements

Prof. N. E. Odell, of the Department of Geology and Geography, University of British Columbia, has been appointed professor of geology in the University of Otago, Dunedin, New Zealand.

Dr. F. D. Richardson, head of the Chemistry Department of the British Iron and Steel Research Association, has been appointed Nuffield Research Fellow in extraction metallurgy at the Royal School of Mines, London. The purpose of this new fellowship is to permit the establishment of an academic research group to work on the extraction metallurgy of both ferrous and non-ferrous metals. Within this field, Dr. Richardson intends that the researches of his team should be devoted to the thermodynamics of slag and metal solutions of importance in extractive processes.

The twenty-fifth anniversary of the granting to the Textile Institute of its Royal Charter and the fortieth anniversary of the foundation of the Institute on April 22, 1910, will be marked by a dinner to be held at Bradford on March 14.

A symposium on molecular structure and spectroscopy will be held at the Mendenhall Laboratory of Physics at the Ohio State University during June 12–17. Further information can be obtained from Prof. Harald H. Nielsen, Mendenhall Laboratory of Physics, Ohio State University, Columbus 10, Ohio.

At the invitation of the Swedish National Committee for Crystallography, the Second General Assembly and International Congress of the International Union of Crystallography will be held in Stockholm during June 27–July 3, 1951. These dates have been chosen in consultation with the Swedish National Committee and with the National Committees of all the countries adhering to the Union, and it is hoped that this early notice will make it possible for crystallographers throughout the world to arrange to attend. Further particulars of the meeting will be available in due course.

TUBERCULOSIS

By JOHN FRANCIS
Bramhall, Cheshire

TUBERCULOSIS is the most important cause of death in Great Britain[1], and is rapidly becoming one of the most important diseases in the tropics. There are about four hundred deaths from tuberculosis every week in England and Wales, which is about twice as many as all other deaths classified by the Registrar General as due to "infective and parasitic" diseases.

To the bacteriologist interested in veterinary or human medicine there are many reasons why the *Mycobacteria* should form the most interesting group of organisms. Their 'acid fastness' distinguishes them from all the other bacteria. Within this one group a greater range of parasitism is displayed than in all other bacteria; from free-living forms such as *Myco. phlei*, which grow on simple media, one passes by stages of increasing difficulty of cultivation to the avian, human and bovine tubercle bacilli. It is of interest to note, however, that although the tubercle bacilli are difficult to isolate, and grow slowly, they were among the first pathogenic bacteria to be grown in synthetic media. *Myco. johnei*, the cause of a chronic enteritis in cattle (Johne's disease), was not cultivated until Twort and Ingram[2] showed that the addition of an extract of other acid-fast bacteria permitted growth. This was in the very early days of the work on vitamins, yet much of their monograph might have been written to-day. The growth factor has only recently been isolated in a state of purity by Francis *et al.*[3]. Finally, we have the leprosy bacillus, which, although one of the first bacteria to be associated with disease in man, when it was observed by Hansen in 1874, remains the only important pathogen that has not been cultivated. In addition, there is the whole question of the relationship of the three types of tubercle bacilli, which should be of interest to all those interested in the genetics of bacteria: the evidence that change of type does occur will be presented by Francis[4]. Again, the pathogenesis of the various forms of tuberculosis and the behaviour of the different types of bacilli in various species represent one of the most interesting fields in comparative pathology[5,6,7].

In view of the foregoing facts, one would imagine that the *Mycobacteria* and the diseases they produce would stimulate a great deal of scientific interest and research. It is true that tuberculosis attracted great public and scientific interest from 1882, when Koch discovered the tubercle bacillus, until about 1915. This period culminated in Great Britain with the publication of the reports of the Royal Commission on Tuberculosis. Since then a great deal of routine work has been done; but it would appear that, with a few notable exceptions, scientific workers in Great Britain have not considered that tuberculosis offers a very attractive field of research. Great effort is expended on the study of every aspect of malignant disease. The chemotherapy of virus infection attracts much interest, and even the common cold is the object of special research effort; but it would appear that nowhere in Great Britain is any similar effort being expended on the study of the agent which is the most important cause of death in Great Britain. It should be pointed out that tuberculosis is much more susceptible to a properly devised scientific attack than many conditions which receive so much more attention: it is, in fact, the last of the great zymotic diseases in civilized communities and is susceptible to the same methods of control (properly modified) as other similar epidemics. This has been amply proved, if proof is necessary, by the virtual eradication of bovine tuberculosis from Finland, the United States, Norway, Sweden and Denmark, and the rapid progress of the Attested Herds Scheme in Great Britain.

There are now 1½ million out of about 9 million cattle in attested herds in Britain, and the Minister of Agriculture announced on November 10 that area eradication would begin in October 1950. There is good reason to believe that the eradication of tuberculosis will make a considerable contribution to the efficiency of milk production, and by lengthening the life of dairy cows and reducing the need for replacements, will permit better selection for milk-yield and other qualities.

The tuberculin test forms the basis of the Attested Herds Scheme in Great Britain, and the whole subject of tuberculin-testing has been intensively studied for many years. Siebert developed P.P.D. (purified protein derivative) tuberculin in 1934, and large quantities of tuberculin protein are produced at the Ministry of Agriculture's Veterinary Laboratory for the 'comparative intradermal' tuberculin test which is used in Great Britain[8]. The great merit of P.P.D. tuberculin is that it can be standardized to ± 0·5 per cent by chemical methods, although concurrent biological tests are always carried out. On the other hand, 'Old Tuberculin' can only be standardized to ± 50 per cent unless large groups of guinea pigs are used. P.P.D. tuberculins do not appear to have been widely adopted for human use in Great Britain. The reasons for this may be that the limitations of the tuberculin test and the importance of careful standardization are less evident in man than cattle, because people are subjected to post-mortem examination immediately after testing much less often than cattle.

There has been so much public controversy about pasteurization that the importance of tuberculous infection from milk has become greatly overestimated, and many members of the general public believe that if milk is freed from tubercle bacilli there will be a rapid decline in human tuberculosis. In fact, the freeing of milk from tubercle bacilli will at best do very little to reduce the incidence of human tuberculosis. Alimentary infection acquired by drinking tuberculous milk is usually mild, and there is good evidence that such infections acquired during childhood protect from pulmonary tuberculosis in adolescence. There is, in fact, an inverse relationship between the incidence of tuberculosis in cattle in country districts and the mortality from human tuberculosis in these districts[9]. All this does not mean that we should fail to make milk safe: it does mean that greater efforts should be made to protect from the more dangerous human infection, and increase resistance by the use of B.C.G.

Most of the extensive work done on tuberculosis in man has been devoted to devising better means of treating the clinically tuberculous; even the danger to medical men and nurses which these patients represent has often been overlooked, and the study of the methods of using and standardizing B.C.G.

vaccine for use in man has been almost completely neglected in Great Britain[10]. This vaccine is prepared from an attenuated strain of the bovine tubercle bacillus isolated from cow's milk by Nocard (one of the pioneer veterinary scientists, who was an authority on tuberculosis), and attenuated by Calmette and Guèrin, between 1910 and 1920, at the Pasteur Institute. Its possible use in the veterinary field has been fully studied in Great Britain; but although it produces a considerable immunity in cattle, the need for vaccination is much less than in man, because animals can be much more easily controlled and radical methods of eradication applied.

During the past few years, there has been a growing interest in tuberculosis, and this has been reflected in the activities of the Tuberculosis Association and the National Association for the Prevention of Tuberculosis. A tuberculin-testing survey is being carried out, and this will form an essential prelude to the extended use of B.C.G. which it is hoped will be rapidly introduced.

The National Association for the Prevention of Tuberculosis was founded in 1896: the second Commonwealth and Empire Health and Tuberculosis Conference*—the first was held two years ago—celebrated the fiftieth anniversary of an organisation which has done much to create public interest and stimulate official action in the problems of tuberculosis, not only in Britain but also throughout the Commonwealth. It is perhaps a natural consequence of human nature, which is essentially improvident, that the greatest interest centred on the papers of Dr. Geoffrey Marshall, Prof. Etienne Bernard, Prof. Jörgen Lehman and Mr. C. Price Thomas, dealing with the chemotherapeutic and surgical treatment of tuberculosis. The meeting was, however, privileged to hear papers from Dr. K. A. Jensen and Prof. Arvid Wallgren on the use of B.C.G. There is now good reason to believe that B.C.G. vaccination will reduce both the morbidity and mortality in exposed groups by 60–80 per cent. It is clearly not possible to isolate everyone in Great Britain suffering from tuberculosis; but a reasonable amount of effort would make it possible to vaccinate persons most heavily exposed to infection. Dr. Wallgren stated that he had not seen miliary tuberculosis or tuberculous meningitis in any child properly vaccinated with B.C.G. In France and the Scandinavian countries, no tuberculin-negative nurse is allowed to enter a tuberculous ward until she has been satisfactorily vaccinated with B.C.G.

In an outstanding paper, Dr. Marc Daniels summed up a discussion on the danger of infection to nurses and students, and attempted to dispel some of the illusions which exist about tuberculosis: "For some reason which I shall never grasp, tuberculosis is singled out as a disease of which people will calmly talk of small occasional infections as a useful method of immunization—a most costly method, since it produces in the general population many thousands of deaths a year. Immunization by uncontrolled infection, for a disease which is often fatal, is an absurdity. It is presumably on the principle that a little tuberculous infection is not a dangerous thing, that one sees in tuberculosis nursing in many hospitals throughout the country a lack of elementary precautions which would be regarded with horror in any ward of other contagious diseases or any maternity or surgical ward. I need only quote, for instance, the lack of instructions to new nursing or domestic recruits attending tuberculous patients for the first time. When I refer to these things, I am referring not to what is the practice in some of our best hospitals, but to what is the practice in a high proportion of other hospitals."

The situation in a country where tuberculosis is receding was illustrated by Dr. C. J. Beckwith, chairman of the Executive Committee of the Canadian Tuberculosis Association. He stated that since the tuberculin test is now positive in only some 20 per cent of Canadians under the age of twenty—indicating a great reduction of infection since the early years of the century—this test is now much more valuable than it was. He advocated the use of B.C.G. for students and nurses, and remarked that the main emphasis in tuberculosis work in Canada had been on the clinical side: epidemiological work had been somewhat neglected.

A very different aspect of the subject was presented by Dr. J. B. McDougall, secretary of the World Health Organisation Expert Committee on Tuberculosis. He stated that there are two to five million deaths a year from tuberculosis. He referred to the importance of the conclusion by the Food and Agriculture Organisation that adequate nutrition is the most important issue now facing the world, and that in many countries methods of food production need to be changed completely. Dr. Ram Chandra Adhikari, of the Bengal Tuberculosis Association, said that in India the incidence of tuberculosis is rapidly mounting; but its true extent is not known. The average income per head of the population is falling; and since the beginning of the century the population has increased by more than 100 million. Industrialization is proceeding apace, with a great movement from villages to the slum areas of towns; the status of some slums has deteriorated during and since the Second World War. Only 7,000 beds are available, whereas at least 500,000 are required. Dr. P. V. Benjamin described the plans for using B.C.G. in India; it is hoped to vaccinate 80–100 thousand people during the next five years.

These last papers served to direct attention to a much wider and more important subject than that of tuberculosis, but one which was, as usual, not discussed—the relationship of population to food supply. As pointed out by Malthus, population has a natural tendency to increase by a geometric progression, whereas, at best, food production only increases by an arithmetic progression. Only two alternatives are open to mankind: population can be kept in check by "disease, starvation and war", or by the much more humane method of preventing conception. No amount of argument, improvement in agriculture, land reform or change of political systems can in the long run enable mankind to avoid these alternatives, yet this whole subject is very largely ignored by politicians and scientific workers alike.

In his presidential address to the Newcastle meeting of the British Association, Sir John Russell did just refer to the need for "Western restraints" if Western standards of living are desired, and it is encouraging that the subject has been frankly discussed by *The Lancet*. It is pointed out in a leading article[11] that medical men can no longer ignore the cumulative effects of preventive medicine, or the fact that every day 50,000 more people sit down to the world's breakfast: "if it is now within our power to reduce death rates it is also within our power to limit birth rates". It quotes Vogt[12], who believes that wherever the Food and Agriculture Organisation finds over-population, its conservation and food production programmes should include contraception programmes. He believes that food production may decrease rather than increase in many areas, and points out that, much more than is generally realized, the achievement of the 'four freedoms' depends on a fifth freedom: freedom from excessive numbers of children. Returning to the problem of tuberculosis in India, it is obvious that efforts will continue to be made to reduce the number of deaths from tuberculosis; but it is difficult to see what real benefit this will produce in a country the population of which is increasing faster than its ability to produce or purchase food. In such circumstances the agricultural and veterinary sciences are of prime importance, and control of disease in man can only be of real benefit if it is combined with efforts to reduce the birth-rate: it is difficult to see what benefit is conferred by preventing ten thousand people from dying of tuberculosis this year in order that, in five years time, they may die of starvation.

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* The full proceedings of this Congress, which was held in London during July 1939, have been published by the National Association for the Prevention of Tuberculosis, Tavistock House N., Tavistock Square, London, W.C.1.

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CONFERENCE OF HOME UNIVERSITIES

THE fourth post-war Conference of the Universities of Great Britain and Northern Ireland was held at the Senate House, University of London, during December 16–17, and was attended by about a hundred delegates and guests.

At the first session, Sir Walter Moberly spoke on his book "The Crisis in the University" in the light of comments that have been made, particularly by Mr. Michael Oakeshott in the *Cambridge Journal*, and by a number of contributors in the November issue of the *Universities Quarterly*. Sir Walter emphasized that although his book was written with a Christian outlook, it is imperative from every point of view that the aims of the universities should be re-defined, and values re-considered. There are also, he said, a number of practical problems requiring decision, such as the communal relations of staff and students and the length of courses; but paramount is the need to ensure that students acquire at the university a philosophy of life and a certainty about ultimate loyalties. He did not, however, want any forced or unreal unity.

Sir Walter was criticized by a number of speakers, who did not share his Christian convictions or accept his disclaimer of any desire to use the universities for the exclusive inculcation of Christianity. Prof. L. J. Russell (Birmingham) thought that the situation had been over-intellectualized, and that the decay of beliefs is due to the breakdown of the social institutions on which they rested. Many of the functions previously performed by the Church and also by the family have passed to other institutions. The associated beliefs have naturally been affected. What is required is a gradual building up of new beliefs firmly based on reality. He strongly supported Sir Walter's concept of the university as an open forum.

Prof. J. P. Kendall (Edinburgh) asked the Conference to compare the Catholic universities of Belgium with the free universities, in which no attempt is made to teach a philosophy of life. Prof. W. M. Calder (Edinburgh) considered that more important than a 'philosophy of life' is 'integrity of intellect'. Mr. Kenneth Urwin (Wales) was concerned with the ultimate results of Sir Walter's prescription, which he thought would be religious tests. Prof. T. M. Knox (St. Andrews) thought that Sir Walter wanted the universities to teach Christianity to those with whom Christian churches have failed. In his opinion, the universities should aim at turning out students who are incapable of not thinking for themselves. Speakers in support of Sir Walter tended to stress the danger of a vacuum. Sir John Maud (Permanent Secretary, Ministry of Education), who was a guest of the Conference, thought that the university should make the student hungry for a 'philosophy of life', but should not teach him any particular one. Prof. D. M. MacKinnon (Aberdeen) urged the necessity of studying the conditions favourable to the open mind and to objectivity. Intellectual honesty is essential if the universities are to survive. The danger of Marxism was emphasized by many speakers; since no voice was raised in its support, the Conference failed to achieve in this respect the open forum advocated by Sir Walter.

At the second session, "The General Education of Students" was the subject, and Prof. F. T. H. Fletcher (Liverpool), speaking as a representative of the Association of University Teachers, gave the opening address. This, he explained, was not a statement of official policy, although the Association of University Teachers has for long been interested in this problem, which is now being generally recognized as the dangers of specialization become more and more apparent. General education, that is, education outside the student's main study, is necessary for three reasons: to increase the value of the student to the community, to increase his effectiveness in his own specialization, and to liberate and enrich the human spirit.

Prof. Fletcher believed that the humanities have more to contribute to general education than the pure sciences and technologies, but Sir Lawrence Bragg (Cambridge) held that the education of the arts student in scientific method and in an elementary knowledge of science is the more urgent part of the problem. The science student is acquainted with the humanities by his previous education; the arts student usually knows little about science.

Prof. H. Hale Bellot (London) considered that the problem centres on the general education of the professor, and instanced as the correct approach to a solution the growing awareness by historians of other fields such as economics. Details of some interesting experiments in general education were given by a number of speakers, and a plea was made by Lord Chorley (Association of University Teachers) for the publication of this information. Lord Lindsay of Birker explained that the new University College of North Staffordshire is being established as an attempt to overcome the evils of specialization. He had been aware for many years that science and arts students were talking different languages and believed that the position is getting worse. At the new College, the four-year honours course which they would provide would begin with a first year in which general education and the correction of school over-specialization would be prominent.

The third session was concerned with "The Place of Technological Education in University Studies", and opened with an address by Sir Lawrence Bragg (Cambridge) and a paper (read in his absence) by Sir Edward Appleton (Edinburgh).

Sir Lawrence supported the founding of separate institutes of technology, on the lines of the Massachusetts Institute of Technology, but emphasized that he did not want to see all technological studies removed from the universities. Such institutes should be as autonomous as universities, should award their own degrees, and should differ from universities only in outlook. His attempt to draw a line between technological and pure scientific research was criticized by a number of speakers, notably Prof. J. B. Speakman (Leeds), who pointed out that his own university had grown from the Department of Textiles.

Sir Lawrence further maintained that while Great Britain has no need to fear comparison with any other in pure science, its record in technology is less satisfactory.

Sir Edward Appleton affirmed that the aim of the university is to produce engineering scientists, and of the technical college to produce engineers. He would support the establishment of one institute of technology, but was more concerned with the improvement of the existing university provision. He regretted the presence in universities of specialized technologies, and instanced glass, rubber, brewing and textiles.

Prof. Andrew Robertson (Bristol) thought that technological institutes such as the Massachusetts Institute of Technology are too little concerned with fundamental principles, and stated that there is criticism in America on this score. Prof. A. F. Burstall (Durham) supported the establishment of an institute of technology, but Sir John Hobhouse (Liverpool) and Prof. J. F. Baker (Cambridge) were in opposition, the latter declaring that it is the national attitude towards technology in the United States that has most to do with the American success in this field. Prof. J. P. Kendall (Edinburgh) thought that the virtue of the Massachusetts Institute of Technology lies in its lavish equipment and in the excellence of its postgraduate instruction. He was also inclined to oppose Sir Lawrence's proposition. In his opinion the fault in Great Britain lies in the arrangement of school education on the assumption that all the pupils would go to the university. Dr. P. Dunsheath (London) was among those who considered that it would be a mistake to remove technological studies from the university, and Sir Roderic Hill (London), by a statement of the actual proportions, rebutted the contention that technological students are in danger of swamping the universities. Principal J. C. Jones (director of education, Regent Street Polytechnic), a guest of the Conference, stressed the harmful effects of the social prestige of the university degree on the provision of courses by technical colleges, and in his reply to the discussion Sir Lawrence Bragg re-emphasized his desire to see new technological institutions, which would give their own degrees.

At the first session the chair was taken by Prof. Lillian Penson, vice-chancellor of the University of London, at the second by Prof. G. C. Field, pro-vice-chancellor of the University of Bristol, and at the third by Sir Hector Hetherington, principal of the University of Glasgow, and chairman of the Committee of Vice-Chancellors and Principals, which convened the Conference.

VOYAGE OF THE ROYAL RESEARCH SHIP *WILLIAM SCORESBY*

THE Royal Research Ship *William Scoresby* sailed on January 11 on a new voyage of ocean research in continuation of the work undertaken by the former Discovery Committee before the War. She will visit South African waters first, and then make observations across the Indian Ocean. The final months of the commission will be spent in studying whales in the West Australian region.

During the past twenty-five years the Discovery Committee has worked under the Colonial Office, and organised a series of expeditions for scientific research, mainly in the Southern Ocean and Antarctic seas, but sometimes also in subtropical and tropical waters. The work is generally referred to as the "Discovery Investigations", and has been concerned principally with deep-sea oceanography and especially with research on whales. The name "Discovery" was adopted because the work at sea began with Captain Scott's old ship, the *Discovery* (now lying off the Thames Embankment), but most of the investigations have been carried out with the Royal Research Ships *Discovery II* and *William Scoresby*. Since 1939 the ships have been on charter to the Ministry of Transport, but in 1949 the Discovery Investigations, together with the ships and scientific staff, were transferred to the Admiralty and now form part of the National Institute of Oceanography, of which Dr. G. E. R. Deacon is director.

The Institute as a whole covers a wider field, but in the next two years both ships will be engaged in the continuation of the Discovery Committee's programme under the general direction of Dr. N. A. Mackintosh, formerly director of research to the Committee. The *Discovery II*, which is the larger ship, is at present refitting for ocean research; her work will be largely in the Antarctic.

The present voyage of the *William Scoresby* is expected to last about ten months. She is a ship of 324 tons (gross) and has some of the features of a trawler and some of a whale catcher. She carries a commercial otter trawl, and there are deck engines and reels with some thousands of fathoms of wire for deep-sea oceanographical work. The equipment also provides for echo sounding. The latest 'world span' wireless apparatus is in part a gift from the Marconi Co. towards the work of the ship. Dr. T. J. Hart will be in charge of the work at sea until the ship reaches Cape Town. With him will be Mr. R. Clarke (who will take over on leaving the Cape), and Mr. R. I. Currie; Lieutenant-Commander A. F. MacFie will be in executive command.

The most important work to be done on the present cruise is to mark whales off the north-west coast of Australia in the southern winter (July and August). First, however, the ship will make a preliminary survey of the Benguela Current off the coast of South-West Africa, which is a region of interest because cold water from the ocean depths wells up like a spring to the surface. The *William Scoresby* formerly surveyed a similar region off the west coast of South America, where the deep water brings certain nutrient salts to the surface, and causes a rich development of the marine fauna and flora.

She will call at Cape Town, East London and Mauritius, and during the voyage will undertake various oceanographical work both in shallow water, and where the bottom slopes down to oceanic depths. Little is known of the water masses and currents of the central Indian Ocean, and during the passage from Mauritius to Fremantle it is expected that valuable observations can be made. If time permits, some trawling may be carried out in Australian waters, and then about two months will be spent off the north-west of Australia. Before the War the *William Scoresby* marked some thousands of whales in the Antarctic, but this was done in the summer months; it is now necessary to mark them in the winter when they migrate towards the equator. At this time of year an important species, the humpback whale, is known to congregate near the north-west Australian coast.

AGAR FROM BRITISH SEAWEEDS

A WELL-ILLUSTRATED account has been published* of the manifold investigations which led to the exploitation of the available supplies of the British seaweeds *Gigartina stellata* Batt. and *Chondrus crispus* (L.) Stackh. as a source of agar. The book is of value in many different directions. Quite apart from the economic importance of the achievement, these researches afford much information on the growth and seasonal development of these seaweeds, and especially of *Gigartina.* They thus provide one of the most important contributions to the autecology of a red seaweed that has so far been published. Moreover, the very extensive explorations which were necessary and which are a testimony to the immensity of the effort involved have afforded much information of general ecological interest with reference to the marine flora, particularly that inhabiting the shores of the Scottish Isles. The various botanists who co-operated in these researches, and particularly Prof. L. Newton, who played an important part, are heartily to be congratulated on the result. It is to be regretted that work of such marked scientific importance can only be achieved when war-time exigencies demand it.

Up to 1939 most of the agar used in Great Britain and other countries was imported from Japan. Even before the Japanese became belligerents, the need to find substitutes became urgent, so that the comprehensive investigations described in this memoir were initiated already early in the War. Of the various red seaweeds that seemed likely to provide a suitable agar, only the two already mentioned can be gathered in sufficiently large quantities, and *Gigartina* is far more abundant than the almost equally suitable and better-known *Chondrus.* It is therefore not surprising that the greater part of the memoir concerns itself with the former. Except for parts of Northumberland, extensive growths of *Gigartina stellata* are met with only on the west coast, the richest localities being those of the Clyde sea-area, where yields of 8–30 lb. per yard of coast were obtained. This seaweed favours rather gently sloping rock surfaces on exposed or semi-exposed coasts and occurs usually at the base of the *Fucus serratus* zone, either as separate tufts or as an almost continuous belt, sometimes as much as twenty yards wide; it is frequently associated with *Himanthalia lorea.*

Little new information on the life-cycle of *Gigartina stellata* is provided. The occurrence of fertilization remains as doubtful as ever, and even these intensive investigations have not brought to light any tetrasporangiate plants. On the other hand, the detailed studies of seasonal development, that had to be undertaken to determine the best methods of harvesting, have added considerably to our knowledge of *Gigartina.* Although in some districts it behaves as an annual, the plants commonly last for three or four years, the new growth in spring arising either from persisting parts of old erect fronds or often in large part from the conspicuous attaching disk. This increases in thickness with the years and exhibits a number of layers, one probably corresponding to each year of growth. Much the same is true of *Chondrus,* where, however, the holdfast is less firmly attached. The growth of the erect fronds terminates between July and September, and soon after this the gel-strength is at a maximum, while the period of maximum carpospore-discharge lasts from September until December.

These observations indicated that, during harvesting, care must be taken not to destroy or remove the holdfast, so that hand-picking rather than shearing was recommended. Furthermore, it was concluded that a single yearly harvest between July and September would be most appropriate, when a maximum yield would be obtained and there would be no interference with the discharge of spores from remaining plants. It is of interest that these conclusions can be correlated with the past experience of some of the crofters on the Scottish Isles who "are aware that the maximum growth has developed by August and September, that the extract is at its best, that the dried weed keeps better and that it is most easily torn from the holdfast at that time".

The extraction was carried out by boiling in lime water and removing the residue. The cooled extract sets to a weak gel. Various methods of hardening the latter were tested, but the one finally adopted was to heat the extract with potassium hydroxide and neutralize with hydrochloric acid; the amount of the former should not exceed 15 per cent of the dry weight of the extract. Best results were obtained by carrying out the potassium hydroxide treatment in an autoclave for eight hours at 20 lb. per sq. in. or for two hours at 40 lb. per sq. in. The resulting agar has a deep yellow colour which can be removed by treatment with activated charcoal. It has a lower melting point, dissolves much more readily and is denser when set than the Japanese product. It contains a much greater percentage of inorganic material; however, this is not an impurity but forms part of the gel complex.

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* A Study of certain British Seaweeds and their Utilization in the Preparation of Agar. By S. M. Marshall, L. Newton and A. P. Orr; with the collaboration of P. W. Carter, E. Conway, K. M. Drew, E. A. Lewis, J. Macnaughtan, H. T. Powell and others. Edited by L. Newton. Pp. viii+184 (12 plates). (London: H.M. Stationery Office, 1949.) 27*s*. 6*d*. net.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Electron Microscope Studies of Normal and Malignant Tissues of High- and Low-Breast-Cancer Strains of Mice

THE consistent finding, by means of the electron microscope, of roughly spherical particles of various sizes but mostly of the order of 200–300 A. in diameter in extracts of tumours, lactating breast tissues, and other tissues of high-breast-cancer-strain mice and their absence in low-breast-cancer strains was reported in *Nature* two years ago[1]; and shortly afterwards[2] it was reported that similar particles were to be found in extracts of milk of the *C3H* high-cancer strain. In the latter communication, it was further shown that it was possible by ultra-centrifugation of tumour extracts to obtain a supernatant apparently free from particles, and it was also reported that the test hybrid mice inoculated with particle-containing extracts described in the first communication had developed mammary tumours, indicating that such extracts were biologically active.

The present position as regards mice injected with extracts tested in the electron microscope prior to our centrifugation experiments is summarized in the accompanying table.

SUSCEPTIBLE HYBRID MICE INJECTED WITH EXTRACTS TESTED IN THE ELECTRON MICROSCOPE

	Extracts with particles present	Extracts with particles absent
No. of mice still alive at the earliest tumour appearance	221	185
No. of tumours	71	7
Average tumour age (mths.)	14·4	18·2
Average age of mice which died free from tumours (mths.)	18·2	15·7
No. of mice still alive	30	36

As regards our earlier centrifugation experiments, the present position is that 13 mice out of 45 injected with sediment have so far developed tumours, while 3 out of 40 injected with supernatant have tumours; but this supernatant (after centrifugation for 1 hr. at 113,000 *g*) still contained a number of particles. In our later centrifugation experiments, however, tumours have developed in mice injected with sediments or with supernatants still containing particles, but no tumours, to date, have appeared in mice injected with supernatants apparently free from particles. It seems, therefore, almost conclusive now that the particles described by us do indeed represent the tumour-inducing agent.

A recent article by Graff *et al.*[3], entitled "Isolation of Mouse Mammary Carcinoma Virus", describes particles obtained directly from the milk of the Paris *R*III strain of mice in which mammary carcinoma is frequent; but makes no mention of our published findings. Their electron micrographs are similar to some of our earlier pictures which we discarded as being unlikely to be a true representation of the tumour-inducing agent; for it was only after fat extraction (either by treating the desiccated tissues with petroleum ether in the cold or by means of a micro-Soxhlet apparatus with petroleum ether boiling below 40°[4]) and treatment with trypsin that our present satisfactory photographs were obtained. In these the particles (still active) are so sharply defined that it is clear that much, if not all, of the apparent variation in size is due to aggregation, and often symmetrical aggregation, of smaller units. That our pre-treatments have not inactivated the agent is shown by our biological results. Neither are the particles artefacts, for distilled water extracts of fresh tissues are also found to contain them.

It is to be noted, too, that Graff and his colleagues appear not yet to have obtained and tested supernatants free from their particles.

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Ground-Wave Propagation Across a Land/Sea Boundary

No useful analytical solution has yet been given for the propagation of vertically polarized radio waves over a non-homogeneous earth. On one hand, Grünberg[1] and other Russian authors have started analytical work on the right lines, but seemingly without being able to arrive at any reasonable answers; on the other, Millington[2] has suggested a practical graphical procedure, based on the general features that a rigorous solution would be expected to possess. Millington's method ignores phase relationships altogether; but recent experimental work indicates that it gives a good estimate of field-strengths[3,4,5].

I have now been able to show that the case of a single land/sea boundary for a flat earth may be adequately treated by an integral equation method allied to that recently introduced into diffraction theory[6,7]. In particular, the two-dimensional problem illustrated in Fig. 1 can be solved exactly. In this model the sea has been replaced by a perfectly conducting, semi-infinite plane sheet; and the transmitter *T* is a vertically polarized line-source (parallel to the boundary *O*) which, together with the receiver *R*, we shall for convenience take at ground-level. Essentially, we have here a generalization of the classic Sommerfeld half-plane diffraction problem; and

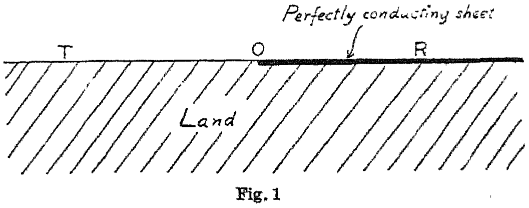

Fig. 1

when the propagation problem is viewed in this light, the possibility of a 'recovery effect' appears less remarkable than it is often described to be.

Let E represent the ground-level field (vertical component of electric field) for the conditions as in Fig. 1; let E_1, E_2, be the corresponding fields for earths all 'land' and all 'sea' (that is, perfect conductor) respectively; and let E_0 be the free-space field. Put $OT = r_0$, $OR = r$, $TR = d$. Then, to sufficient accuracy, the simplest results of interest to have been derived are as follows: (a) for R between T and O, $E = E_1$; (b) for R on TO produced, under conditions to be stated presently,

$$\frac{E}{E_0} = \frac{E_1}{E_0} + \sqrt{\frac{2r}{\pi r_0}}\,\frac{2\exp(-i\pi/4)}{\sqrt{kd}\,\sin\beta}, \tag{1}$$

where $k = 2\pi/\lambda$ is the free-space propagation constant, and β is the (complex) Brewster angle for the land. With the field expressed in this form, restriction to a line-source is no longer necessary, provided that TR remains perpendicular to the coast-line.

Formula (1) is only valid when T is a large numerical distance from O, that is, for $(kr_0/2)\sin^2\beta \gg 1$. In this case

$$\frac{E_1}{E_0} = -\frac{2i}{kd\sin^2\beta}, \tag{2}$$

so that the second term on the right of (1) soon predominates as r/r_0 becomes appreciable. Since $E_2/E_0 = 2$, we then have

$$E = \sqrt{\frac{2r}{\pi r_0}}\,\frac{2\exp(-i\pi/4)}{\sqrt{kd}\,\sin\beta}\,E_0 = \sqrt{\frac{2r}{\pi r_0}}\sqrt{E_1E_2}. \tag{3}$$

In Fig. 2, equation (1) has been used to plot a field-strength curve for $\sin\beta = 1/3$, $r_0 = 300\,\lambda$. Such conditions would scarcely be met in practice, but are chosen to make E_1 and E_2 strikingly different, so that a marked recovery effect is obtained. The curve derived from Millington's graphical method is shown dotted. At $r = r_0$ his procedure always gives, as regards field-strengths,

$$E = \sqrt{E_1E_2}, \tag{4}$$

which differs from (3) by the factor $\sqrt{2/\pi}$, representing a reduction of 2 db. As r tends to infinity, Millington's curve also lies 2 db. above the accurate one, so that the two differ for the most part by this amount, though they become remarkably close as the boundary is approached.

For the case considered, Millington's argument has no theoretical support, since (4) can only be justified when r and r_0 represent large numerical distances for *both* media. In so far as it is permissible to seek such accuracy, the only relevant experiment[3] tends to confirm that, when one of the media is a quasi-conductor, Millington's method gives field-strengths about 2 db. too great.

If T and R are at arbitrary heights h_T and h_R, the formula corresponding to (1) is much more complicated. However, it is simplified again if (a) h_T and h_R are both sufficiently great for ray theory to apply in the case when the earth is all land; in the example chosen, this requirement is $h_T, h_R > 2\lambda$; (b) R lies on $T'O$ produced, where T' is the image of T in the earth's surface. Under these conditions, taking $h_T = h_R$, it can be shown that the expected height-gain relationship is valid for h_T up to $6\,\lambda$. Furthermore, use of the height-gain factor to derive the field for $h_T = h_R = 0$ from that for $h_T = h_R = 2\lambda$ gives a value differing from that obtained by direct application of (1) by only 0·1 db. This affords a valuable check on the calculations.

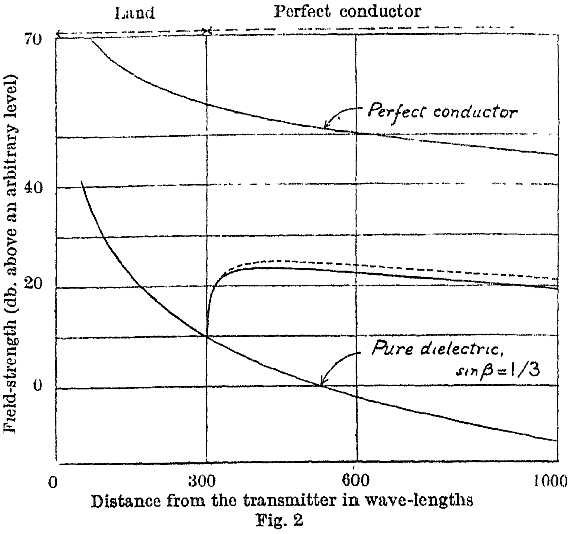

Fig. 2

Finally, it may be mentioned that the above method can be applied to the case of two arbitrary media, if use is made of approximate boundary conditions which are valid in view of the rapid attenuation of waves below the earth's surface (see, for example, ref. 1). The formulæ for this general case are naturally more complicated, but are capable of giving numerical results.

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Macroscopic Space Charge in Electrolytes during Electrolysis

SINCE the publication of Hittorf's famous paper in 1853, it has been assumed, in general, that in every small element of volume of an electrolyte undergoing electrolysis, the sum of the charges on the negative ions is equal to the sum of the charges on the positive ions, namely, that during electrolysis macroscopic space charge does not exist. Apparently, Hittorf based this assumption on some experimental results which were obtained by Faraday in 1831.

Macroscopic space charge is known to exist in a uniformly ionized column of a gas which is conducting an electric current. Since the column of electrolyte is also uniformly ionized throughout, and since the current in each consists of positive ions moving toward the cathode together with negative ions moving toward the anode, it seems reasonable to expect that macroscopic space charges might exist in an electrolyte during electrolysis.

Apparatus and procedures were developed which permitted the accurate determination of the potential distribution along a uniform column of electrolyte during electrolysis. The potential was found to be a non-linear function of the distance from the cathode, and it was shown that this non-linearity could not be due to concentration changes brought about by the electrolysis. It was also shown that this non-linear relation could exist only if macroscopic space charges existed in the electrolyte.

The distribution of the macroscopic space charge along the column was calculated from the potential distribution. In every case it was apparent that the column of electrolyte contained four space-charge regions. Very near the cathode the charge was positive. The next quarter of the column contained negative space charge. Very near the anode the space charge was negative. The remainder of the column (about three-quarters of it) contained positive space charge. The largest space charge was observed within 1 mm. from an anode; it required an excess of 2,000,000 Cu^{++} ions over the SO_4^{--} ions per c.c., an excess of only 3 ions for every 10^{12} Cu^{++} ions originally present. The space charges in other parts of the column were very much smaller than this.

The distribution of the electric field-strength along the column of electrolyte was also calculated from the potential distribution. Although the magnitudes of the space charges were very small, they had very appreciable effects on the field-strengths. For example, the observed mean potential gradient in the explorable part of the 40-cm. long column (to within 1 mm. of each electrode) was 16 per cent less than the average potential gradient $\left(\frac{8000}{40} \text{ mV./cm.}\right)$ in the cases of two solutions. Since the actual field-strengths are not constant and are so much different from those calculated from the potential difference between the electrodes and their distance apart, any direct-current method for determining electrolytic conductivity must take space charge effects into account.

The eight electrolytes studied were 0·0024 N solutions of copper, zinc and nickel sulphates and chlorides, zinc acetate and aluminium sulphate. In each case the column of electrolyte was 40 cm. long by 8 cm. wide by 8 cm. deep, and the electrodes were made of pure metal, the metal being that of the positive ions.

The results of this research force one to the conclusion that macroscopic space charges do exist in an electrolyte during electrolysis, and that this phenomenon is more complicated than it is in uniformly ionized gases. It is expected that this newly discovered phenomenon will cause a re-examination of the theories concerning electrolysis.

A detailed account of this work will appear in the very near future in the *Journal of Chemical Physics*.

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Supersonic Vibration Potentials (Debye Effect) in Colloidal Solutions

THE interesting results reported by Yeager, Bugosh, Hovorka and McCarthy[1] with respect to the Debye effect in electrolytic solutions induce us to give an account of the results obtained by us in recent years in colloidal solutions.

The apparatus used was similar to that described before[2], so we will give here only the main points of difference from the original apparatus. The radio-frequency generator consisted of a 100-watt Hartley oscillator and a push-pull amplifier stage utilizing two 500-watt tubes. The amplifier consisted of a high-frequency amplifier stage, converter and two intermediate-frequency amplifier stages; maximum amplification 700,000. This amplification factor turned out to be much larger than necessary in our colloidal solutions of arsenic trisulphide (in our previous experiments we used silver iodide). It was reduced to 22,500. The background noise was equivalent to ± 3 μV.

We tried to measure the velocity amplitude of the supersonic wave by measuring the acoustical pressure, by means of a hydrostatic balance with a hollow prism; but, like Yeager *et al.*, we could not obtain satisfactory results.

Our colloidal solution of arsenic trisulphide contained 163 gm. of As_2S_3 per litre; the electric conductivity was 73×10^{-5} Ω^{-1} cm.$^{-1}$, the viscosity $\eta = 0{\cdot}013$ C.G.S.

The Debye effect was quite large in this solution; the potentials measured in the solution varied from 45 V. maximum to 12 V. minimum, which yields, after division by 22,500, an amplitude for the supersonic vibration potential of 33,000/22,500 = 1·47 mV.

For an (estimated) velocity amplitude $v_0 =$ 2·75 cm./sec., and a ζ-potential of 100 mV., our simple formula[2]

$$\Phi_0 = \frac{mnD\zeta v_0 g}{4\pi\eta\sigma}$$

leads to 7 mV.; therefore, the discrepancy between theoretical and experimental values, reported in our previous note (factor 100), is less serious now.

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[1] Yeager, E., *et al.*, *J. Chem. Phys.*, **17**, 411 (1949).

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Double Orbit in the 30-MeV. Synchrotron

AN examination of the shape of the gamma-ray output pulse of the Malvern 30-MeV. synchrotron[1] shows two distinct pulses, both when the machine is working as a synchrotron and as a betatron. When the machine is working as a synchrotron, both pulses occur after the radio-frequency is switched off, one at the expected time, the other much sooner.

The existence of the earlier (or spurious) pulse may perhaps be explained in terms of a resonance phenomenon (discussed by Courant[2]) between the second harmonic of the betatron oscillation frequency and the angular rotational frequency.

The equation for radial oscillations about the equilibrium orbit of a betatron to the first order is

$$\ddot{\rho} + (1 - n)\,\omega^2\rho = 0, \qquad (1)$$

where ρ is the displacement of the electron, ω is the angular rotational frequency and n is $-\,d(\log H)/d(\log r)$, H being the axial field at a radius r. Thus when $n = 0{\cdot}75$, the oscillation frequency is equal to half the rotational frequency, since $(1 - n)^{1/2}\,\omega = 0{\cdot}5\,\omega$.

If n is nearly equal to 0·75, the position of maximum ρ will slowly precess. Now equation (1) is only a first-order equation, but in general there are small terms also in ρ^2 and $\dot{\rho}^2$, which make the solution of equation (1) a complicated function, in which the frequency is dependent on the amplitude. The second-order terms have been investigated in detail by W. Walkinshaw (unpublished), who has shown that they are large enough to produce a frequency change of the order of 3 per cent for an oscillation amplitude of about 8 per cent of the orbit radius. Thus it might happen that even if the oscillation amplitude maximum processed for small oscillations, an oscillation amplitude might exist such that no precession occurred. In this case a small circumferential inhomogeneity would act as a forcing term of exactly twice the oscillation frequency. This would cause a resonance of fixed amplitude. In such a resonance (which is analogous to 'ferro-resonance' which can occur with a saturating choke the inductance of which varies with current), the phase of the oscillation sets itself such that the force integrated with respect to the displacement over one cycle is equal to the energy lost per cycle, in this case zero. It can be shown that such an oscillation is stable over a limited region, and if perturbed the oscillation amplitude will oscillate about the unperturbed amplitude. This type of resonance can only be started by somehow giving the electron a large displacement: it cannot build up from a small oscillation, because the natural frequency for small oscillations is not related to the forcing frequency.

If at injection the electrons have a range of oscillation amplitudes, some will damp down to the equilibrium orbit, and others will damp down to an oscillation of fixed amplitude about the equilibrium orbit.

When the radio-frequency is switched off, both these orbits will contract and the spurious orbit will probably lose its phase relationship with the inhomogeneity, but will continue as a free oscillation of large amplitude, thus hitting the target before the true orbit by a time dependent on the oscillation amplitude.

To test this hypothesis, pieces of laminated iron were placed around the magnet just outside the pole pieces. These produced disturbances in the field, and altered the relative sizes of the two pulses. Positions could be found which put the electrons completely in one or other of the two orbits, and it was observed that when the spurious orbit was eliminated there was no significant change in output.

In view of the very special shape of magnetic field required, it is strange that this phenomenon occurs on the Malvern machine, since measurements of the magnetic field indicate a value of n rather less than 0·75.

This phenomenon, though interesting, is not likely to occur often in practice, since the magnetic field must be a very special shape before the two orbits can both occur within the confines of the 'donut'. Even if it does occur, however, the effect would not appear to be serious, since any electrons which can get into the spurious orbit in the first place are likely to stay in the 'donut' unless the betatron equilibrium orbit changes significantly during the betatron phase. The energy difference between the two pulses also will be too small to be important.

I wish finally to acknowledge helpful discussion on this question with Messrs. Walkinshaw and Goward, of the Atomic Energy Research Establishment.

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Atomic Energy Research Establishment,
Harwell. Oct. 11.

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Phase-Shift Formula for Many-Body Collisions

WE consider the scattering of a particle ($\mathbf{R}$) with momentum $\mathbf{K}$ and mass M by a nearly spherically symmetrical system of N particles ($\mathbf{r}_s$), taking into account the 'adiabatic' deformation of the scattering system during the collision.

In the time-independent Schrödinger equation for the total system of the $N + 1$ particles ($\mathbf{R}$) and ($\mathbf{r}_s$), we replace the interaction potential $V(\mathbf{R}, \mathbf{r}_1, \ldots, \mathbf{r}_N)$ by the effective potential $V_l(R, \boldsymbol{r}_l)$. The latter is defined as follows: we average the interaction potential over the angles of the vectors $\mathbf{r}_s$; the resulting dependence on R and r_s we approximate by the form $V_l(R, \boldsymbol{r}_l)$, choosing suitably the function $\boldsymbol{r}_l = \boldsymbol{r}_l\{r_1, \ldots, r_N\}$. The index l indicates the dependence of the function $V_l(R, \boldsymbol{r}_l)$ and of the 'mean distance' $\boldsymbol{r}_l$ on the azimuthal quantum number l of the incoming particle. For collisions with heavy atoms, a different $\boldsymbol{r}_l$ may be introduced for each electron shell. We expand the solution of the Schrödinger equation of the system ($\mathbf{R}, \mathbf{r}_s$) with the effective potential in a series of spherical harmonics referring to the angular co-ordinates of the incoming particle:

$$\Phi(\mathbf{R}_1\mathbf{r}_1, \ldots, \mathbf{r}_N) = \sqrt{\frac{\pi}{2}}\,\frac{1}{KR}\,\Sigma\,(2l+1)\,i^l F_l(R, \boldsymbol{r}_l)\, P_l(\cos\theta_R)\,\varphi_l(\mathbf{r}_1, \ldots, \mathbf{r}_N). \qquad (1)$$

The F_l are defined as the solutions of the radial part of the Schrödinger equation for the particle ($\mathbf{R}$) in the effective potential $V_l(R, \boldsymbol{r}_l)$. In this Schrödinger equation r_l is to be understood as a fixed parameter. The functions F_l are subject to boundary conditions of the usual type chosen so that they are normalized to unity with respect to the variable R.

By inserting the expansion (1) in the Schrödinger equation of the total system with the effective potential $V_l(R, \boldsymbol{r}_l)$, we get for the coefficients $\varphi_l(\mathbf{r}_1, \ldots, \mathbf{r}_N)$ the Schrödinger equation of the scattering system ($\mathbf{r}_s$) perturbed by the potential (expressed in Hartree units) due to the incoming particle ($\mathbf{R}$):

$$U_l(r_s) = \sum_{s=1}^{N} \left\{ M\pi \int_0^{\boldsymbol{r}_l^*} \frac{\partial V_l(R, \boldsymbol{r}_l)}{\partial r_s}\, F_l^2(R, \boldsymbol{r}_l)\, dR \right\}^2 \qquad (2)$$

where $\boldsymbol{r}_l^* \equiv \boldsymbol{r}_l^*\{\boldsymbol{r}_l\}$ is a given function of $\boldsymbol{r}_l$; for $\mathbf{R} \geqslant \boldsymbol{r}_l^*$ we have $\dfrac{\partial V_l(R, \mathbf{r}_s)}{\partial \mathbf{r}_s} = 0$.

By using the Hartree procedure, this equation may be split up into N one-particle Schrödinger equations and treated further by the perturbation method.

From our approximate solution (1), the phase shift can be derived by considering only the asymptotic behaviour at $R \to \infty$ of the solution $\Phi(\mathbf{R}, \mathbf{r}_s) \to S X_n(K\mathbf{R})\chi_n(\mathbf{r}_s)$ without the usual[1] assumptions about the solution at finite distances. Here $\chi_u(\mathbf{r}_s) \equiv \chi_u(\mathbf{r}_1, \ldots, \mathbf{r}_N)$ are the unperturbed eigenfunctions of the system of ($\mathbf{r}_s$) particles. Thus it is possible to get the phase shift for inelastic scattering with the simultaneous excitation or ejection of several ($\mathbf{r}_s$) particles. The general formula is too complicated to be given here. In the case of elastic scattering by a spherically symmetric system, we get (Hartree units)

$$\sin \eta_l = - \sqrt{\frac{\pi}{2}}\,\frac{2M}{K} \int d\tau_s\, \varphi_l(\mathbf{r}_s)\, \chi_0(\mathbf{r}_s) \int dR$$

$$\sqrt{\frac{\pi}{2} KR}\, J_{l+1/2}\,(KR)\; V(\mathbf{R},\mathbf{r}_s)\, .\, F_l(R,\mathbf{r}_l\{r_s\}\,), \quad (3)$$

where $\mathbf{r}_s$ stands for the set $\mathbf{r}_1, \ldots, \mathbf{r}_N$ and $d\tau_s$ for the product $d\tau_1, \ldots, d\tau_N$. This formula gives either the Born approximation when the potential $V(\mathbf{R}.\mathbf{r}_s)$ tends to zero, and therefore $F_l(R,\mathbf{r}_l) \rightarrow \sqrt{RK}\, J_{l+1/2}\,(KR)$, or the partial cross-section formula when we assume a rigid potential putting $V(\mathbf{R},\mathbf{r}_s)$ and thus also $F_l(R,\mathbf{r}_l)$ independent of r_s. (For $l \neq 0$ when the velocity V of the (**R**) particle tends to infinity, (3) gives Born approximations for phase shift.)

The application of the above method to the cases of elastic scattering of negative mesons by atoms and of neutrons by deuterons is in preparation and will be published elsewhere.

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Utilization of Aspartic Acid and Asparagine by Yeast

MUCH work has been carried out upon the mechanisms whereby yeast is able to utilize nitrogen from amino-acids for its nutrition, and the mechanisms worked out by Ehrlich and Stickland illustrating nitrogen uptake are well known[1,2]. These and other authors (for example, Thorne[3]) have been concerned with the value of amino-acids to yeasts simply as sources of nitrogen. Working with aspartic acid and asparagine, however, we have for some time observed that yeast growth has been stimulated under some conditions to a remarkable extent if either aspartic acid or asparagine has been present in nutrient solutions containing sugars and inorganic salts and nutrilites under various conditions of wort aeration. Under several conditions of experimental procedure, always with good aeration, it has been found that aspartic acid and asparagine added in relatively large amounts have always had the effect of increasing the yield of yeast obtained from a standard amount of fermentable sugar. Thus, under one set of conditions, it has been found that the addition of 1 gm. of asparagine would yield an additional 2·7 gm. of yeast (at 27 per cent dry matter) or 0·729 gm. of yeast dry matter. Also, while we have never been able to obtain yields of yeast (at 27 per cent dry matter) greater than 210 per cent of the hexose sugar supplied, this figure has, under some conditions, been greatly exceeded when either aspartic acid or asparagine has been present in the wort in sufficient amount.

These facts we attribute to the assimilation of the amino-acids as such by the growing yeast, the carbon skeleton of those substances being taken into the yeast. The mechanisms of Ehrlich and Stickland both neglect the possibility of assimilation of amino-acid *carbon* by yeast. If all the carbon of asparagine were assimilable by yeast, 1 gm. of asparagine (0·363 gm. carbon) would give 0·77 gm. of yeast dry matter (carbon average, 47 per cent). This assimilation can take place only when the yeast is at the same time supplied with fermentable sugars (probably as a source of the energy necessary to enable the assimilative mechanisms to proceed). Assimilation of the two amino-acids and subsequent yeast growth can, however, take place in the absence of biotin.

Recent work[4,5] has suggested that bacterial cell substance may be synthesized from sugars and ammonia in the following manner. Pyruvic acid (from normal fermentative breakdown of hexose) combines with carbon dioxide to form oxalacetic acid. This then combines with ammonia to form aspartic acid, which is presumed to form the basis for protein structure of the bacterial cell. Biotin is stated to catalyse part of this chain of reactions.

It appears to us that our observations may quite easily be explained upon such a basis as the above. If the normal yeast assimilative mechanism (by which hexose-sugar carbon and ammonia nitrogen are combined to form cell protein) passes through the stages noted above, it could be presumed that aspartic acid (or its amide asparagine) could be true intermediates in cell synthesis. In such a case, biotin would not be needed if aspartic acid (or amide) were supplied to the yeast, and such certainly does appear to be the case. The fermentable sugar is necessary to provide energy and probably other carbon groups for later cell anabolism.

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The Precipitin Reaction and Antibody Valence Studied with the Aid of Radioactive Isotopes

HEIDELBERGER and his colleagues[1] have made extensive quantitative studies of serological reactions using micro-methods for the determination of total nitrogen in specific precipitates, supplemented by the determination of the amount of dye present when dye-azoproteins were used as antigens. Other investigators have used antigens containing iodine[2], copper[3] and iron[4] to enable the amount of antigen to be determined in precipitates obtained from a wide range of mixtures of antigen and antibody.

For various immunochemical investigations during the past few years[5,6,7] we have been using antigens and antibodies labelled with radioactive isotopes. As antigens we have used lipovitellin containing phosphorus-32, proteins treated with mustard gas sulphone containing sulphur-35, and iodinated proteins containing iodine-131. We have also used antibodies labelled with iodine-131 or sulphur-35, for we have found that the introduction of small amounts of iodine or mustard gas sulphone groupings into antibodies, such as those to egg albumin, serum globulin

Composition of precipitates obtained with iodinated ovalbumin and antisera to iodinated horse serum globulin
All the weights given refer to amounts/ml. antiserum used.

Mixture	Antigen added		Composition of the precipitate				
	N (μgm.)	I (μgm.)	Total N (μgm.)	Total I (μgm.)	Antigen N (μgm.)	Antibody N (μgm.)	Mol. ratio* antibody/antigen
a	47·8	23·6	272	15·2	30·7	241	1·9
b	23·9	11·8	242	8·4	17·1	225	3·2
c	8·0	3·9	122	2·8	5·6	116	5·0

* Calculated on the basis of nitrogen contents and molecular weights of 15·76 per cent and 40,500 for egg albumin, and 16 per cent and 165,000 for the antibody.

and lipovitellin, does not destroy the ability of these antibodies to form specific precipitates with appropriate antigens.

A few typical results obtained in experiments with iodinated ovalbumin containing iodine-131 and an antiserum against iodinated protein are given in the accompanying table to indicate the use of the method. The results recorded here are for (*a*) mixtures with excess antigen, (*b*) in the equivalence zone and (*c*) with excess antibody. The complete analysis of the precipitate, by iodine-131 and total nitrogen determinations, can often be made in duplicate using less than 0·5 ml. of antiserum, the limiting factor being the sensitivity of the determination of total nitrogen. When iodine-131 of high specific activity is used for the preparation of the antigen, duplicate nitrogen and iodine-131 determinations are possible on as little as 0·5 mgm. of precipitate.

In experiments with the lipovitellin–antilipovitellin system, with the antigen labelled with phosphorus-32 and the antibody with iodine-131, we have been able to show that antilipovitellin sera contain relatively large amounts of antibody which react with the phospholipids of the lipovitellin antigen.

In other experiments we have been using 3 : 5-diiodotyrosine containing iodine-131 to study the inhibiting effect of this compound on the precipitin reaction between iodoproteins and their antibodies. In order to avoid removal of attached diiodotyrosine, the precipitates were not washed before analysis; but by carrying out the precipitin reaction in the presence of 5 per cent heavy water, we were able to determine the amount of supernatant solution adhering to the precipitate, and hence the uncombined diiodotyrosine.

Analyses of the precipitates obtained with varying amounts of antigen, antibody and inhibitor have shown that the amount of combined inhibitor in the precipitates is very small or possibly zero; it is certainly less than one molecule per twenty molecules of antibody. We believe that these results offer strong support for the view that the antibodies we have studied are univalent in the sense that each molecule has only one specific combining group for the corresponding antigen. Antibody valence is still the subject of controversy (see reviews in refs. 8 and 9), and while some authorities favour the theory of univalence, others believe in multivalence or at least bivalence. We are hoping that the use of antigens and antibodies labelled with radioactive isotopes may throw further light on this problem. A more complete account of our results will be given elsewhere.

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Significance of Tryptophane in Human Nicotinic Acid Metabolism

THERE is much evidence that tryptophane can replace nicotinic acid in the nutrition of the rat (for literature, see Spector[1]); but relatively little is known about the significance of tryptophane in human metabolism of nicotinic acid. Perlzweig *et al.*[2], and Sarett and Goldsmith[3,4], demonstrated an increase in the urinary excretion of N-methylnicotinamide after oral administration of *l*- or *d,l*-tryptophane to humans; but since this substance is not the main metabolite of nicotinic acid[5,6], and since its fate in the body is still not clear[7], it is not possible from their results to estimate with any degree of certainty the amount of nicotinic acid produced from the dose of tryptophane.

Since it is now known that N-methyl-2-pyridone-5-carboxylamide is the chief metabolite of nicotinic acid[5,6], and since a specific colorimetric method is available for its determination in urine[6], an experiment was made to study the effect of ingestion of *l*-tryptophane on the urinary excretions of N-methylnicotinamide and N-methyl-2-pyridone-5-carboxylamide by humans. Two healthy adult Europeans (subject 1 a male of 34 years; subject 2 a female of 36 years) were given a diet consisting of everyday foods (white bread, butter, jam, beef, peas, potatoes, fruit, breakfast cereal and tea) in amounts which satisfied their usual appetites. The amount of each food eaten daily was kept constant throughout the experiment. The diet was sampled and analysed for nicotinic acid by the method of Dann and Handler[8]. The urinary excretions of N-methylnicotinamide (method of Huff and Perlzweig[9]) and N-methyl-2-pyridone-5-carboxylamide (method of Holman and de Lange[6]) were determined on successive 48-hour periods before and after the ingestion of *l*-tryptophane (6 gm. on two successive days).

The results (Table 1) show a considerable rise in the excretions of N-methylnicotinamide and, particularly, of N-methyl-2-pyridone-5-carboxylamide

Table 1. Effect of *l*-tryptophane on the urinary excretion of metabolites of nicotinic acid by humans.
(NA = nicotinic acid; NMN = N-methylnicotinamide; P = N-methyl-2-pyridone-5-carboxylamide)

Subject No.	48-hr period No	Dietary intake of NA (mgm.)	*l*-Tryptophane supplement (gm.)	Urinary excretion (mgm.)	
				NMN	P
1	1	79 2	0	13·0	27 4
	2	83 3	0	10·1	22·1
	3	85·5	0	14·5	24·9
	4	78·1	0	17·1	31·1
	5	79·0	12	44·3	87
	6	78·1	0	24·3	71
	7	69·2	0	21·3	45·8
2	1	38·3	0	8·4	13 8
	2	46·1	0	10·0	12·5
	3	45·0	0	8·3	12·9
	4	44·0	0	8 8	12·0
	5	46·5	12	35·1	137
	6	40·3	0	19·3	53
	7	39·3	0	14·4	25·6

following the dose of tryptophane. Since the increase was shown by both metabolites, and since the specificity of the method for the latter compound has been studied in some detail[6], there can be little doubt that a relatively large amount of nicotinic acid was formed from tryptophane. The extra amounts of N-methylnicotinamide and N-methyl-2-pyridone-5-carboxylamide excreted after the dose are together equivalent to 145 mgm. nicotinic acid for subject 1 and to 181 mgm. for subject 2. The amount of nicotinic acid made available to the body by the 12 gm. of tryptophane is probably still greater than this, since it was shown[6] that after the ingestion of 500 mgm. of nicotinamide only 70–77 per cent could be accounted for in the urine as N-methylnicotinamide and N-methyl-2-pyridone-5-carboxylamide. These results were obtained when a large excess of tryptophane was present in the body, and smaller amounts may not have a proportionate effect. However, it is of interest to note that 1·1 gm. tryptophane, stated to be the average daily consumption in the United States of America[10], would, if the above conditions were applicable, provide as much as 13–17 mgm. of nicotinic acid a day.

The present evidence suggests that protein deficiency, and particularly tryptophane deficiency, may play a significant part in pellagra. Preliminary results obtained in this laboratory through the helpful co-operation of Dr. Grek and other members of the medical staff of the Coronation Non-European Hospital, Johannesburg, indicate (see Table 2) that in pellagra the urinary excretion of N-methyl-2-pyridone-5-carboxylamide falls to zero, and rises after treatment with nicotinic acid and other B vitamins at a slower rate than normal. If these findings are observed in further cases of pellagra, it would be of interest to study the effect of tryptophane on the excretion of N-methylnicotinamide and N-methyl-2-pyridone-5-carboxylamide by pellagrins.

Table 2. Urinary excretion of N-methyl-2-pyridone-5-carboxylamide by pellagrins before and after treatment with B-vitamins

Subject	Sex	No. of days treatment	Urinary excretion of N-methyl-2-pyridone-5-carboxylamide (mgm./24 hr.)	
			Before treatment*	After treatment†
Bantu pellagrin	M	8	< 0·05	22·4
Bantu pellagrin	F	11	< 0·05	29·4
Normal European	M	5	13·0	59·4

* The Bantu patients were given no vitamin treatment and a normal hospital diet for the first 24 hr. while the urine specimen was collected.
† Treatment consisted of improved diet and 100 mgm. nicotinic acid, 50 mgm. pyridoxine, 50 mgm. aneurin, 5–10 mgm. riboflavin given daily by intra-muscular injection for the first five days, then orally; crude liver extract, 1–2 ml., was given by injection for the first five days. In the case of the European, the vitamins were given orally.

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External Potassium and the Membrane Potential of Single Muscle Fibres

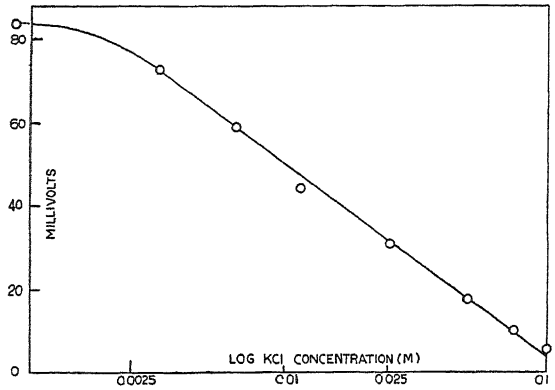
ONE important supporting fact for the concept of the membrane potential of muscle and nerve being a diffusion potential[1] was the demonstration of a rectilinear relationship between the logarithm of the external potassium concentration and the measured membrane potential, according to the Nernst equation:

$$\text{membrane potential} = 58 \log_{10} \frac{K^+ \text{ internal}}{K^+ \text{ external}} \text{ mV.}$$

This was shown to be approximately true by Cowan[2] for the injury potential of crab nerve and by Shanes[3] for the 'anaerobic' fraction of the injury potential of frog nerve. Doubts as to the significance of the rectilinearity of their curves[4,5] seem to be met, at least in the case of squid giant axon, by the work of Curtis and Cole[6], although these authors hesitated to ascribe the membrane potential completely to the potassium concentration gradient. Using the classical injury potential technique, a similar relationship has been demonstrated in frog muscles by Steinbach[7] and by Boyle, Conway and co-workers[8,9]. Thus a potential *v.* log $[K^+]$ relation has been found for both nerve and muscle.

There are, however, limitations to the injury potential technique; the potential falls off rapidly, and due to the uncertain short-circuiting through the interfibrillar fluids, the maximum measured potential is far below the true value. Such difficulties are overcome by the method of impaling a single muscle fibre with a micro-electrode[10]. The normal membrane potential of frog sartorius fibres was thus found to be 95 mV., approximately the value expected on theoretical grounds. (This is with 3 *M* potassium chloride filling the micro-electrodes, after Hodgkin[11]. The curve in the accompanying graph, however, was obtained with electrodes filled with isotonic potassium chloride and hence shows lower values[10].)

Varying the external potassium chloride, by substituting equimolar amount of sodium chloride in normal frog Ringer solution, gives a straight line relationship as shown in the graph. Each point on the curve represents the average of six measurements on different fibres, after having been equilibrated for 5–10 min. The general shape of the curve resembles those of Curtis and Cole and of Conway and Kane; but with the much higher values of potential obtained



and consequently the greater voltage range, the non-linear portion at low concentration of potassium ions becomes less conspicuous. Increasing potassium chloride to two or four times isotonicity caused the potential to become reversed in polarity to − 3 and − 7 mV. respectively. The average slope of eight different curves is − 44 mV. ± 9·5 mV. (S.D.), for a tenfold increase of the external potassium concentration. This is similar to slopes found in other cells and tissues by other authors[7,12], but is definitely lower than the theoretical value of 58 mV.

More extensive studies on salt effects will be presented elsewhere.

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Reversal of Glycogenetic to Glycogenolytic Action of Desoxycorticosterone in Rats

It was shown in a series of papers from this Laboratory that desoxycorticosterone has *in vitro*, in the concentration of 1–5 mgm. per cent, an inhibitory effect on glycogen formation[1–4] of the isolated muscle, which has since been explained as a glycogenolytic action[5]. This was the more unexpected since it seems certain that this adrenal cortical steroid has in the intact animal a distinct glycogenetic action[6–8]. We therefore tried whether it might be possible to reverse also the glycogenetic activity of desoxycorticosterone in the intact animal by increasing the dose to an inhibitory or glycogenolytic one.

The experiments were performed on normal and on adrenalectomized male rats of 150–200 gm. weight on the stock diet. For experiments with normal rats the animals were fasted for 24 hr. Then desoxycorticosterone acetate in the doses given in Table 1 was injected in oily solution intraperitoneally. One hour later, 2 c.c. of 50 per cent glucose solution was given by stomach tube. After three hours, the animals were killed and glycogen estimated in liver and muscle in the usual way[7]. Table 1 shows the results.

Table 1. Normal animals

Series	Normal rats	No. of animals	Glycogen (gm. %)				Treatment: de oxycortico terone acetate intraperitoneally
			Liver	S.E. ±	Muscle	S.E. ±	
1	24 hr. starved	5	0·10	0	0·25	0·03	--
2	3 hr. after 1 gm. glucose	5	3·31	0·43	0·55	0·04	—
3	,,	5	1·89	0·16	0·44	0·03	2 mgm.
4	,,	5	0·71	0·19	0·25	0·04	20 mgm (narcotic dose)

Normal animals after 24 hr. fasting have very low liver and muscle glycogen values (series 1). If they are fed 1 gm. glucose, the liver glycogen is raised to 3·31 per cent and muscle glycogen to 0·55 per cent (series 2). If, 1 hr. before feeding glucose, 20 mgm. desoxycorticosterone acetate was injected intraperitoneally and the animal went into a narcosis-like state, scarcely any glycogen was produced either in the liver or in the muscle (series 4). With 2 mgm. desoxycorticosterone (series 3) the glycogen production was somewhat smaller than in the normals.

The same was observed in adrenalectomized animals. Adrenalectomy was performed as usual from the back and the animals were treated for the first three days with 3 mgm. desoxycorticosterone daily, in order to combat the post-operative shock. During the next three days they were not treated, and then fasted for 24 hr. They were then given desoxycorticosterone by injection in different doses (see Table 2). One hour afterwards, 2 c.c. of 50 per cent glucose solution was given by stomach tube. Three hours later they were killed and the liver glycogen was estimated. Table 2 shows these results.

Table 2. Adrenalectomized animals

Series	Rats	No. of animals	Glycogen in liver		Treatment: desoxycorticosterone acetate intraperitoneally (mgm.)
			gm. %	± S.E.	
5	adrenalectomized, 3 hr. after 1 gm. glucose	5	2·59	0·28	0·1
6	,,	5	1·76	0·49	0·5
7	,,	5	1·84	0·56	1·0
8	,,	5	2·04	0·57	2·0
9	,,	5	1·59	0·22	6·0
10	,,	5	1·07	0·36	10·0*
11	,,	5	0·37	0·13	20·0†
12	normal controls	6	3·67	0·39	—

* Incomplete narcosis. † Complete narcosis.

The injection of 0·1–2·0 mgm. desoxycorticosterone caused production of glycogen from glucose; but with 10 mgm. desoxycorticosterone intraperitoneally, less glycogen was formed; and with 20 mgm. desoxycorticosterone, which produced narcosis, no glycogen was formed (series 5–11). For comparison we have at the same time, together with these adrenalectomized animals, again used six normal animals without desoxycorticosterone treatment (series 12). They showed a glycogen production equal to that in series 2.

Thus, whereas desoxycorticosterone has glycogenetic properties if given during a longer period to adrenalectomized rats, we have succeeded with single large doses in inhibiting totally the glycogen-production from glucose. These large doses have a narcosis-like effect (Selye[9]), which might be the result of a similar inhibition of the metabolism of the central nervous system.

Desoxycorticosterone thus has an effect on glycogen production and also on glycogen breakdown. Whereas with small doses the former becomes apparent, with large doses, on the contrary, glycogen formation is inhibited in the intact animal just as in the isolated surviving muscle.

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Production of Antisera in Rabbits using Calcium Alginate as an Antigen Depot

THE production of agglutinating and precipitating antisera in rabbits is normally a slow, painstaking process requiring numerous intravenous inoculations. This is especially true of streptococcal antisera. Inoculation of the antigen in a bland excipient which would be slowly enough absorbed to create a constant immunizing process would obviate the necessity for these repeated intravenous inoculations. I believe that calcium alginate fulfils this requirement.

The alginates are salts of alginic acid derived from seaweed. The calcium salt in 5 per cent aqueous concentration forms a gel which will not pass through even a wide-bore needle. A 5 per cent solution of the sodium salt is a viscous fluid which, on the addition of one per cent calcium chloride, is changed immediately into the calcium gel. For parenteral administration the inoculum is mixed with 5 per cent sodium alginate, and this is converted into calcium alginate by the immediate injection of a half volume of 1 per cent calcium chloride into the same site. The *p*H of the sodium alginate was 7·2 in the present work. Increasing the alkalinity is said to increase the rate of absorption.

Rabbits were anæsthetized with ether, their bellies clipped and a 1·0-ml. concentrate of 100–200 ml. of dead broth culture was emulsified in 4·0 ml. of 5 per cent sodium alginate and inoculated intraperitoneally. Immediately afterwards, 2·5 ml. of 1 per cent aqueous calcium chloride was inoculated into the same site. Test bleedings made from the ear three weeks to a month later showed unsatisfactory antibody response. The animals were then given a single large intravenous dose in some instances or three doses at four-day intervals in others. Ten days after the last intravenous inoculation, test bleedings were made again. In all cases the sera had agglutinin and precipitin titres as good as, or better than, those obtainable by any other method. Antisera were produced against the following organisms: *S. typhi-murium* (OH); *Staph. pyogenes*; *Str. agalacticæ* (eight strains); *E. coli* (OH); *Proteus* (OH); *Erysipelothrix rhusiopathiæ*; *Erysipelothrix monocytogenes*; *S. choleræ-suis* (OH).

The OH titres of the *E. coli* and *S. choleræ-suis* antisera were + + + + at 1–25,600, while the *Str. agalacticæ* antisera agglutinated well at 1–1,280 to 1–2,560. The *E. coli* rabbit received only a single intravenous inoculation. All the *Str. agalacticæ* antisera gave good immediate reactions to the Lancefield precipitin test[1]. I have been engaged for the past four years in the production of *Str. agalacticæ* antisera, and the results show that only about a third of the rabbits inoculated according to the Lancefield method give satisfactory antisera of research standard.

It is generally well known that when the reticulo-endothelial system has been conditioned to the reception of a given antigen, even although the blood antibody titre has been allowed to fall to a low level, a subsequent inoculation of the same or a related antigen is sufficient to raise the titre to a high level again. It is also known that serum-producing animals which have traces of antibody before immunization produce sera of higher titre than those with no preliminary antibody; for example, horses with traces of diphtheria antitoxin.

The rationale of the present method is to condition the reticulo-endothelial system over a period of three weeks to a month to the reception of continuous small doses of antigen by release from the alginate as the latter is absorbed, and to follow this by intravenous inoculation of tolerable doses of the same antigen so as to flood the reticulo-endothelial system and thereby increase antibody production. I recommend the intraperitoneal inoculation of a 1·0-ml. concentrate of culture emulsified in 4·0 ml. of 5 per cent sodium alginate, followed immediately by massage and the inoculation of 2·5 ml. of 1 per cent calcium chloride into the same site. The animal is then left for three weeks to a month and given three inoculations at four-day intervals of the same antigen intravenously. A test bleeding is made ten days after the last inoculation.

In the instance of the present *Str. agalacticæ* antisera, 100 ml. of twenty-four hour glucose broth culture was given intraperitoneally, and this was followed three weeks later by three intravenous inoculations of 20 ml. of the same culture given at four-day intervals. All these amounts had been concentrated to 1·0 ml.

I think that this method of immunization should replace the usual one of intermittent intravenous inoculation of graded dosage for the production of antibacterial sera. Less work is involved, and it is very much safer for the life of the animal. Because the bacteria are entrapped in the alginate, numbers far in excess of the lethal dose can be given. In the present work, rabbits killed six weeks after the alginate inoculation still had encapsulated collections of alginate in the peritoneal cavity. Histological examination of these showed them to be finely intersected with trabeculæ rich in reticulo-endothelial cells. The intraperitoneal route was chosen because a plentiful supply of blood vessels and reticulo-endothelial cells is available there.

My thanks are due to Dr. George Blaine, of the Strangeways Laboratory, Cambridge, for the supply of alginate and advice on its use.

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Effect of Calcium and Atropine on the Histamine- and Acetylcholine-induced Contraction of Unstriated Muscle

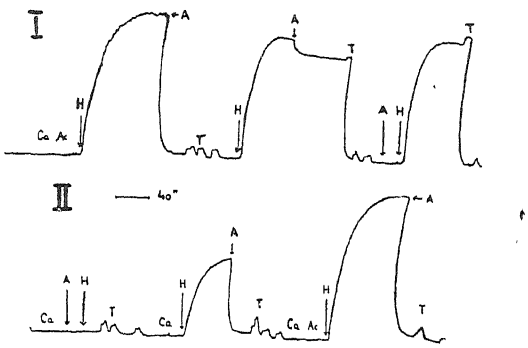
Several authors have attempted already to influence the action of histamine with atropine. The amount of atropine required to block the effect of acetylcholine does not affect the action of histamine on unstriated muscle[1]. According to Forst[2] and Feldberg[3], the contraction induced by histamine in unstriated guinea-pig muscle is only slightly diminished by small doses of atropine.

Our experiments were carried out on an isolated strip of guinea-pig ileum suspended in the usual way in Tyrode's solution in a Magnus flask. Fifty-two experiments on fourteen strips of five pieces of guinea-pig ileum showed that calcium chloride in the end concentration of 10^{-3} gm./ml. markedly diminished the size of contraction brought about by histamine (end concentration 10^{-7} gm./ml.). If, at the peak of such a calcium ion – histamine contraction, atropine (end concentration 10^{-6} gm./ml.) was added, the strip relaxed. If, on the other hand, atropine was administered together with calcium ion previously to histamine, histamine remained ineffective. Atropine, in presence of calcium ion, thus causes relaxation or inhibition of histamine contraction (see Fig. 1).

The contraction caused by calcium ion with histamine is also relaxed by 'Antistin' (Ciba 2-phenylbenzylaminomethyl-imidazoline-hydrochloride) in an end concentration of 10^{-6} gm./ml. as well. Contractions caused by histamine in the end concentration of 10^{-7} gm./ml. without additional calcium (see above) were very little affected by this dose of atropine and could not be inhibited by previously administered atropine. To determine whether changes in osmotic pressure of the system caused by additional calcium chloride were responsible for the effects reported, a control series was run using equimolar quantities of sodium chloride instead of calcium chloride. Under these conditions, atropine did not affect the histamine contraction.

We also examined the effect of calcium chloride (for doses, see above) on contractions caused by acetylcholine (end concentration 2×10^{-7} gm./ml.). In thirteen experiments on seven strips of intestine from three guinea-pigs, we found that calcium increases acetylcholine-induced contractions.

It is well known that intestinal strips gradually lose sensitivity against acetylcholine when repeatedly treated with atropine, even after most careful washing, retaining at the same time full sensitivity against histamine. If a strip thus treated is put into Tyrode's solution containing 10^{-3} gm./ml. calcium chloride and 2×10^{-7} gm./ml. acetylcholine (end concentrations) —which has previously proved to be ineffective—the strip responds with a larger contraction to the administration of histamine (end concentration 10^{-7} gm./ml.) than when there is no acetylcholine added (Fig. 2). Thus whereas acetylcholine by itself was ineffective, it increases, in presence of calcium ions, the histamine-induced contractions. These contractions could also be relaxed by atropine (end concentration 10^{-6} gm./ml). Calcium is essential for both the synergic action of acetylcholine and the effect of atropine.



Ca, 10^{-3} calcium chloride; Ac, 2×10^{-7} acetylcholine; A, 10^{-6} atropine; T, three washings with Tyrode's solution; H, 10^{-7} histamine hydrochloride. (All numerals represent gm./ml. end concentrations)

Fig. 1. Acetylcholine potentiates in presence of calcium ions the action of histamine. The contraction is relaxed by atropine. Contractions caused by histamine alone are not influenced by atropine given either before or after histamine

Fig. 2. Atropine in presence of calcium ions blocks or relaxes contractions caused by histamine Acetylcholine in presence of calcium ion potentiates the action of histamine

Both curves were obtained from the same strip of guinea-pig ileum in direct succession

There have been indications[4] that histamine acts on the unstriated muscle cells and on the parasympathetic nerve endings. This could explain our results: calcium ion inhibits the direct muscular action, leaving the nervous action unaffected, which would be further strengthened by the synergetic action of subliminal doses of acetylcholine.

Even though the reported changes in ionic milieu are much greater than could be expected under physiological conditions, our experiments suggest that the action of histamine is greatly influenced by ionic conditions. A full account of this work is appearing in *Arch. int. Pharmacodyn.*

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Demonstration of Glycogen and Lipids in the Cytoplasm of Human Neutrophilic Leucocytes

The cytoplasm of the neutrophilic human leucocyte contains lipid granules which can be stained with Sudan Black[1]. On the other hand, studies with the Best Carmine stain[2], with the Bauer–Feulgen method[3], and with the recent periodic acid–leucofuchsin method[4], have demonstrated the presence of glycogen in the cytoplasm of these cells, which has been reported to stain either diffusely or granularly. By means of the phase-contrast microscope, the stained cytoplasm has been seen to be spotted; but it was not quite clear whether the spotted appearance was due to the staining of the granules or of the intergranular spaces[4].

To solve this question, attempts were made to stain both glycogen and lipids in one blood smear. After visual examination of the cytoplasmic glycogen with the periodic acid method, unfixed smears were treated in a saturated solution of Sudan Black (Grübler Co.) in 70 per cent alcohol for 5 min. Although no lipoid solvents had been used before the Sudan treatment, the lipid stain was not satisfactory. The following method, in which the order of the two staining procedures is reversed, gave good results. (1) Fixation of dried smears in 70 per cent alcohol for 5 min. or in 99 per cent alcohol for 3 sec.; may be omitted. (2) Sudan Black solution as above for 5 min. (3) Washing in 70 per cent alcohol. (4) 0·5 per cent solution of periodic acid in water for 5 min. (5) Thorough washing in running water. (6) Schiff's reagent, prepared as usual, for 15–20 min. (7) Three washings in sulphur dioxide – water, each for 5 min. (8) Running water for 10 min. (9) Drying with blotting paper, balsam.

With this method, the neutrophilic leucocytes stained black-purple. The cytoplasm was purple with fine black-brown granules, and the nucleus remained colourless. In the cytoplasm, no uncoloured spots were to be seen. Consequently, the spotted appearance of the cells in the preparations stained with the periodic acid method only (*vide supra*) is due to the lipoid granules, not stainable with the glycogen method. It is of interest that in the eosinophilic leucocyte, similarly, the intergranular spaces only are stained by the periodic acid method[4].

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Mutations Induced in *Drosophila* by Ingested Phosphorus-32

SEVERAL recent papers[1–4] have described the cytological effects of radioactive phosphorus (P^{32}) assimilated into plant tissues. As was to be expected, there was a general similarity between the structural changes so induced and X-ray changes. To our knowledge, no published account has yet appeared of the induction of gene mutations by phosphorus-32 or other radioisotopes.

It occurred to one of us that different radioactive elements, owing to their specific physiological activities, might differ in their intimate association with certain genes and therefore in the genetic changes they induced. Such differences, if they could be observed, might well provide a new line of attack on the problems of gene structure and gene function. In the search for specific genetic actions of radioisotopes, the study of mutations, which can be located precisely by tests for linkage and allelism, was likely to be more informative than the study of structural changes in the chromosomes. Work has now begun on the production of mutations by radioisotopes in *Drosophila melanogaster*.

The first radioisotope to be used was phosphorus-32, for the following reasons. It is easy to obtain and safe to handle without elaborate apparatus. As phosphorus is a major constituent of all living tissue, phosphorus-32 may be expected to be absorbed in quantities sufficient to produce workable mutation-rates. Being a constituent of nucleic acid, phosphorus will come into very intimate contact with genes, including those of the germ line. When phosphorus-32 disintegrates the nucleus is transformed into sulphur-32, thus enforcing a gross chemical change *at the site* of the late phosphorus-32 atom, in addition to any more diffuse changes due to the ionizing effect of the β-ray. Finally, as the nucleic acid is distributed all along the chromosomes, mutations induced by phosphorus-32 would be expected to serve as controls to mutations produced by elements of more specific physiological activities and, possibly, more specific mutagenic activities.

The highest dose of phosphorus-32 administered was 1 mc. per bottle (at the time of adding the solution to the bottle, two days before introducing the parent flies). This killed all the larvæ at one or another stage before pupation. Some even reached the final instar, but did not pupate. The next dosage, 0·1 mc. per bottle, drastically reduced the number of emergent treated flies, though their appearance was normal. The third dosage, 0·01 mc. per bottle, had no appreciable effect on the emergence relative to the untreated controls.

Flies emerging from the 0·1 mc. bottles were further studied. Their activity was measured with a Geiger counter at the Royal Cancer Hospital. Though the activity was variable, the mean figure was 0·0122 μc. per fly, two to three days after emergence.

Treated males were mated to *ClB* females to test the *X*-chromosomes in their sperm for mutations. 259 *X*-chromosomes gave 19 lethals and 4 visible mutations. This is an overall mutation-rate of 8·9 per cent made up of a lethal mutation-rate of 7·3 per cent and a visible mutation-rate of 1·5 per cent. The ratio of visible to lethal mutations appears to be much higher than that found for X-ray effects, namely[5], 1 to 10–20. Of the controls, 92 chromosomes showed no mutations.

There was an indication of heterogeneity in mutation-rates between flies of the two replicate treatments (5 and 6) and according to day of emergence (shown by index numbers 1, 2 and 3). The results are summarized in the accompanying table.

Series	5^1	5^2	5^3	6^1	6^2
No. of chromosomes tested	55	57	50	45	52
No. of mutations	4	3	2	8	6
Per cent mutations	7·3	5·3	4·0	17·8	11·5
Fertility	150	324	493	92	169

χ^2 for heterogeneity in mutation-frequency for the five series does not reach the 5 per cent level of probability. It is 7·425 for four degrees of freedom with a probability of 10 per cent. But the parallelism between reduction of fertility and mutation-rate is very suggestive.

The figures given for fertility are the total progenies obtained from the five treated males used for each series. It can be seen that there is a high inverse relation between mutation-rate and fertility. Since the highest dose of phosphorus-32 killed all the larvæ, and the next highest killed most of them, it is reasonable to suppose that the survivors would have a fertility inversely related to their individual content of phosphorus-32. There is, therefore, an indication that variation in mutation-rate is due to variation in phosphorus-32 content as indicated by fertility. The decrease of mutation and increase of fertility with later emergence implies inter-larval competition for the phosphorus-32.

The overall lethal mutation-rate here observed (7·3 per cent) is the rate that would be expected[6] for an X-ray dose of 2,500 r.[2]. It is possible, by estimating the integral dose received by an individual fly during the present irradiation with phosphorus-32, to compare the relative mutagenic efficiencies of X-rays and phosphorus-32 β-particles. The treated flies had been exposed to radiation from ingested phosphorus-32 from the first larval instar. Practically all the phosphorus-32 is taken in during the five days of logarithmic growth prior to pupation. The effect of these five days is approximately equivalent to irradiation for two days at the maximum size. From pupation to insemination (the latest point at which radiation will cause mutation in the sperm), a period averaging nine days under the conditions of the experiment, the fly remains of practically constant size, and intake of phosphorus-32 is negligible. The total period of irradiation was therefore eleven days and the initial amount of phosphorus-32 present (estimated from measurements made on the ninth day) was $1 \cdot 8 \times 10^{-2}$ μc. per fly. Therefore in this period $1 \cdot 8 \times 10^{-2} \times (1 \cdot 0 - 0 \cdot 59) = 7 \cdot 4 \times 10^{-3}$ μc. of phosphorus-32 are destroyed. 1 μc. destroyed of phosphorus-32 corresponds to the absorption of 800 gm.r. in tissue[7]. Therefore the total amount of energy emitted (or available for absorption) is $7 \cdot 4 \times 10^{-3} \times 800 = 5 \cdot 9$ gm.r.

Since the *Drosophila* fly has dimensions smaller than the range of phosphorus-32 β-particles in unit density material, not all this energy will be absorbed within the fly. If the fly is considered as a sphere of radius a, then the mean path within the sphere of β-particles produced by phosphorus-32 uniformly distributed throughout it will be equal to a. If then the absorption is approximately exponential, with an effective linear absorption coefficient μ, the amount of energy absorbed within the sphere is equal to total energy emitted multiplied by $\{1 - \exp(-\mu a)\}$.

The *Drosophila* pupa is shaped like a cylinder tapered at both ends with a maximum diameter 0·8 mm. and maximum length 3 mm. The average weight of a fly is of the order of 1 mgm. and the density is nearly 1. However, for the purposes of this comparison, the fly is considered as a sphere of volume 1 c.mm., and radius therefore 0·62 mm. The value of μ in unit density material[8] is 7·6 cm.$^{-1}$, and therefore about 38 per cent of the total energy emitted is absorbed within the fly. This corresponds to an integral dose of 2·2 gm.r. The corresponding integral dose, received by a fly of weight 1 mgm. as a result of an X-ray dose of 2,500 r., is 2·5 gm.r.

It would be unwise to attach much significance to the similarity of lethal mutation-rate per gram roentgen for the two agents. For while the phosphorus-32 has been active in the flies during all stages of development, the X-rays are always applied to males containing mature sperm. It is doubtful whether the mutability of the germ track is the same at all stages. There are indications[9] that the *apparent* mutation-rate is higher in ripe sperm than in unripe sperm, possibly through cell selection eliminating mutations at earlier stages. This would mean that the real mutation-rate per gram roentgen would have to be much higher for phosphorus-32 in order to produce the same apparent mutation-rate as X-rays acting on mature sperm.

The high mutation-rate of visibles produced by phosphorus-32 (1·5 per cent) corresponds to the expectation from 12,000 r. of X-rays[9]. Such a conclusion is less reliable than that based on lethals, owing to the small number of visibles detected[4] and the personal element involved in their detection. Additional work will be required to confirm whether phosphorus-32 is really four times as efficient as X-rays in the production of visible mutations.

Further work with this and other isotopes is proceeding. From the location of the sex-linked lethals so far produced, there is no reason to doubt that the phosphorus-32 mutations, like X-ray mutations, are randomly distributed.

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Dextran as a Diluent for Univalent Antibodies

THE attempts by various workers to find a satisfactory substitute for bovine albumin as a suspension medium in the (antigen + univalent antibody) reacting system have been reviewed by Mourant[1]. The polydispersoid polysaccharides known as dextrans[2] possess certain properties which we considered might enable them to replace bovine albumin in such a system. This supposition has been well substantiated in respect of the use of the substance as a diluent for univalent anti-*D* in routine grouping procedures.

Several fractions of differing molecular size-range were tested, the most satisfactory being that known as *GL*/50/3, which has a mean molecular size of 75,000 and contains 0·94 per cent sodium chloride. The optimum final concentration of this substance in the reacting system was found to be 1·0–1·5 per cent. Evaluation of the various fractions was based on two points: (1) the results obtained with a dextran-diluted univalent antiserum were required to agree exactly with those obtained by the same antiserum diluted with 20 per cent bovine albumin over a series of a thousand group tests; (2) the average quality of the agglutinates was required to be no poorer than that obtained with the albumin-containing system. The fraction *GL*/50/3 satisfied these criteria completely.

A serious disadvantage of this substance is its lack of latitude as regards optimum concentration. It was found necessary to titrate the dextran against the chosen antiserum using OR_1R_2 and Orr erythrocytes as indicators, a concentration giving the strongest agglutinations of positive cells together with absence of rouleaux formation of the negative cells being thus arrived at. This difficulty has up to now precluded the routine use of this substance as a suspension medium for standard cells in the detection of anti-*Rh* antibodies, but further work is proceeding along these lines.

Since this report was prepared, a communication by Grubb[3] has come to hand demonstrating a similar effect.

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A Fungus in *Ectocarpus granulosus* C. Agardh near Plymouth

During April and May 1949, *Ectocarpus granulosus* C. Agardh growing at mean low-water spring tide at Saltstone, which is about 1½ miles up the River Sal, from Salcombe, was heavily infected with a parasitic fungus. The Saltstone habitat is a purely marine one and is sheltered in the river estuary. The *Ectocarpus* grows attached to small stones and to other algæ in the *Vaucheria*-community. By July most of the *Ectocarpus* plants had disappeared from the locality.

The fungus is identical with *Eurychasma Dicksonii* (Wright) Magnus, a member of the Saprolegniales, which was first described in 1879 by Prof. E. P. Wright[1] from Ireland and later in 1887 by John Rattray[2] from Scotland. No records seem to have been made of this parasite in England. According to Sparrow[3] the fungus has a wide distribution on the Atlantic coasts of Europe. It infects other species of *Ectocarpus* as well as certain other members of the Phæophyceæ.

Thallus of *Ectocarpus granulosus* C. Ag., infected with *Eurychasma Dicksonii* (Wright) Magnus. (The arrow shows a discharged sporangium of the fungus)

Observations made on living plants show the size of the mature sporangium of the fungus to be about 70 μ × 90 μ (slightly larger than given by Sparrow). Each sporangium opens by one, two or rarely three short discharge tubes. Zoospores either emerge directly from the sporangium and swarm with two unequal flagella which are subapically disposed, or encyst inside the sporangium. Zoospores have been studied both while alive and after fixing with osmic acid and staining with 0·5 per cent Aniline Blue. They are hyaline, more or less rounded or slightly pyriform; each zoospore measures 3 μ × 4 μ. The longer flagellum is about four times the diameter of the zoospore itself, and the shorter, two to three times. The stages through which the protoplasm of the fungus passes, inside the host cell, agree well with the original description of the species.

Examination of several algæ in the same locality indicates the presence of other parasitic fungi. Marine fungi have so far received but little attention in England, and the part they play in causing the death of animals and plants must not be overlooked.

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Changes in the Response of Silkworm Eggs to Rotational Force during Cleavage

The eggs of the silkworm (*Bombyx mori*) have been used in several cases for studying the biological effects of rotational force (Kawaguchi[1], Tirelli[2]). But an interesting change in the response of silkworm eggs to centrifuging which occurs during the early cleavage stages escaped the notice of the authors. The change can be observed both morphologically in the process of pigment formation and physiologically in the rate of oxygen consumption of the eggs. Experiments which revealed the change were carried out in the Department of General Zoology, University of Budapest, in 1946 with eggs of the race Moretiana. The eggs were subjected for one hour to a centrifugal force of about 3,000 g, which caused a visible stratification of their contents. The treatment was applied either in (1) an 'early' stage, centrifuging starting two to three hours after the eggs were laid; or (2) a 'late' stage, treatment commencing fourteen to sixteen hours after oviposition. The temperature was approximately 26° C. throughout the experiments.

Eggs subjected to the treatment in the 'early' stage did not develop pigment at all, remaining bright yellow indefinitely, as at oviposition. In the eggs centrifuged in the 'late' stage, this suppression of pigment formation did not occur; they darkened simultaneously with the controls. The pigmentation in such 'late' centrifuged eggs is somewhat irregular. The pigment granules are not distributed evenly over the whole surface but are concentrated into patches. But neither their colour nor the time of their appearance differs in any way from the normal.

As regards oxygen consumption, there was a similar difference between eggs subjected to centrifuging in early and late stages respectively. In general, the oxygen consumption early after treatment was about 60–70 per cent of the normal; after late treatment it was about 80–90 per cent. As all experiments yielded practically identical results, only

Experiment	Control	Early treatment	Late treatment
8/6	19·5	13·9	17·2
8/9	20·7	12·2	18·1
8/8	25·8	18·0	20·4

a few typical examples are given here (oxygen consumption in cm.³ per hour per 500 eggs at 26° C.).

The results agree with those of Bodine and Boell[3], who ultracentrifuged the eggs of the grasshopper *Melanoplus*. Depression of respiration after ultracentrifuging has also been observed in the eggs of *Ascaris* (Huff and Boell[4]) and in liver cells of the frog (Chantrenne[5]). An explanation of these phenomena was given by the latter author, who finds that the cyanide-sensitive respiratory enzyme cytochrome-oxidase of the liver cells is associated with sedimentable granules of the cytoplasm; thus centrifuging separates the enzyme from its substrate, causing a marked decrease in the respiration (notably the cyanide-sensitive respiration, as shown by Bodine and Boell[3]). The general importance and widespread occurrence of such enzyme-containing, sedimentable cell constituents (Jeener and Brachet[6], Brachet[7]) indicates that the explanation of Chantrenne (fully supported by Brachet) holds good in all cases—including silkworm eggs—where decrease of respiration was observed after centrifuging. In the case of silkworm eggs, however, it may be added that the enzyme or enzymes associated with the sedimentable cell constituents must also be responsible for the pigment formation. (Knowing the close connexion between oxidations and pigment formation, one may even think of a double effect of the same enzyme system.)

There seem to be two possible explanations of the difference between the response of the eggs centrifuged in the early and late stages respectively: (1) either the viscosity of the cytoplasm is changed in relation to that of the sedimentable constituents containing enzymes of pigmentation and respiration; or (2) the position of these sedimentable elements is changed so that they migrate from less viscous regions of the cytoplasm to regions of higher viscosity. Tirelli[8] has shown that the viscosity of the cell sap of silkworm eggs increases continuously after oviposition, and Kawaguchi[1] explains some of his results by the assumption that three hours after oviposition the viscosity of the egg cytoplasm is higher than one to two hours after oviposition. These observations are in favour of explanation (1). However, there are several facts which indicate that explanation (2) may be equally true. It is known that the cleavage nuclei migrate from the interior of the egg cytoplasm to the cortical layer (*Keimhautblastem*), taking with them the yolk-free cytoplasmic islets which surround them. According to Bataillon and Tchou-Su[9], this migration takes place about twenty hours after oviposition at 20° C., but possibly much sooner at 26° C., at which our experiments were carried out. Furthermore, it is known from the experiments of Kawaguchi[1] that the cortical layer has a much higher viscosity than the inner cytoplasm, which is readily stratified by a rotational force of about 1,075 g applied for 10 min., whereas the cortical layer remains quite unaffected by this treatment. As it is probable that enzyme-containing sedimentable constituents of the cytoplasm would be found in the yolk-free islets surrounding the nuclei, the migration of these islets to regions of higher viscosity during the early stages of cleavage can explain the fact that these sedimentable constituents are less affected by the same rotational force in the 'late' than in the 'early' stage. It is hoped to check the validity of this explanation later by further—mainly histological—investigations.

ALEXANDER WOLSKY

Unesco Science Co-operation Office
for South Asia,
Delhi.
Aug. 25.

[1] Kawaguchi, E., *J. Fac. Agric. Hokkaido Univ.*, **38**, 111 (1937).

[2] Tirelli, M., *Roux Arch. EntwMech.*, **142**, 200 (1944).

[3] Bodine, J. H., and Boell, E. J., *J. Cell. and Comp. Physiol.*, **7**, 455.

[4] Huff, J., and Boell, E. J., *Proc. Soc. Exp. Biol. and Med.*, **34**, 626 (1936).

[5] Chantrenne, H., *Acta Biol. Belg.*, **3**, 99 (1943).

[6] Jeener, R., and Brachet, J., *Acta Biol. Belg.*, **1**, 476 (1941).

[7] Brachet, J., "Embryologie Chimique" (Paris–Liège, 1937).

[8] Tirelli, M., *Atti Roy. Acad. Lincei*, **11**, (6), 80 (1930).

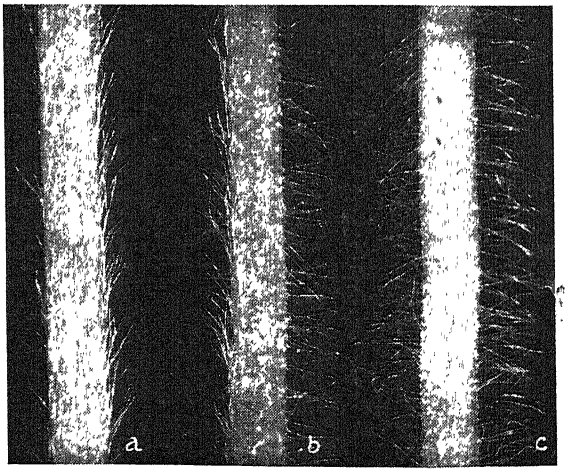
[9] Bataillon, E., and Tchou-Su, *Arch. Anat. Micr.*, **29**, 285 (1933).

A Chimera in the Cultivated Strawberry

In July 1949, Mr. J. E. Spickernell, provincial fruit specialist, East Midlands, discovered a variant in the *M.*40 clone of Royal Sovereign strawberry. In these plants the petiole hairs were adpressed upward, instead of spreading (that is, perpendicular to the petiole). In 757 plants of the same stock at this Research Station, 7·5 per cent were found to be of this variant form, and 1·1 per cent had both normal and variant crowns. In two plants some leaves with spreading hairs on one side of the petiole and adpressed ones on the other were found (see illustration), and in another, two consecutive runner plants on a single stolon had adpressed and spreading petiole hairs respectively.

This evidence suggests that the variant originally arose as a mutation, in the form of a sectorial or mericlinal chimera, from which normal vegetative propagation by runners has resulted in a population containing three types of plant, some having normal spreading petiole hairs, some adpressed and a few continuing as sectorial or mericlinal plants with both types of petiole hairs.

The variant plants resemble normal Royal Sovereign in every recognizable character except that of the petiole hair pose, and no significant



Portions of three petioles from a single strawberry plant showing: (*a*) adpressed hairs, (*b*) half adpressed and half spreading, and (*c*) spreading hairs correlation was found between the number of variant plants and crop-weight of plots containing differing numbers of them. From the point of view of certification schemes, however, it is very desirable to eliminate the variant from stocks used for raising runners. Stocks will be maintained for investigation. Evidence so far suggests that the variant is confined to certain stocks sent from the Research Station in 1947 and 1948.

A note by Darrow[1] on a change in length of fruit-stalk, possibly due to mutation, is the only previous report of mutation in the strawberry that has come to my notice.

I wish to thank Mr. Spickernell for first reporting the variant, and Mr. M. B. Crane, Miss D. Wilson and others for further information.

W. S. Rogers

East Malling Research Station,
Kent.
Aug. 27.

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[1] Darrow, G. M., *J. Heredity*, 17, 404 (1926).

Soil and Vegetation in British Somaliland

The welcome publication of the first volume of Major Glover's work[1] directs attention to certain points regarding the soil and pastures in British Somaliland, which have been investigated for some years past, though little has been published. Opinion is divided on the extent and importance of the soil erosion, and the whole problem has recently been reviewed in detail by Brigadier (now Sir) Gerald Fisher[2], lately military governor.

Two factors, however, seem to have been generally overlooked.

First, the geological aspect. Probably in Upper Eocene times rift faulting in the Gulf of Aden trend (east-north-east) gave rise to the great northern Somaliland scarp, which now rises to heights of some 1,500–2,400 metres, and forms the backbone of the Somaliland Protectorate. Since then, for a matter of perhaps forty million years, all but a slight coastal strip has been continuously above the sea, and at roughly the same altitude as now. In Pleistocene times the country was strongly affected by the East African Pluvial periods, when great erosion took place, and later deposition of thick beds of red alluvium in many of the valleys.

The state of the countryside at the present day is fundamentally a legacy from the Pleistocene period. Lack or sparseness of soil-cover over much of the highlands may be ascribed to the intense Pleistocene denudation, and not to present-day erosion. It may even be that soil and vegetation in the highlands have been for the past five thousand years or more, and still are, slowly recovering under difficult conditions rather than deteriorating.

Secondly, an interesting phenomenon, which seems hitherto largely to have escaped notice, appears from a study of many air photographs of the country. A number of these, covering large areas of semi-desert plains of the Sawl Haud in the east of the Protectorate, and parts of the Haud in the south, show rhythmic patterns of the vegetation, which is concentrated in the form of tiers of arcs of mixed trees, shrubs, plants and grasses. These photograph black against a light background of bare desert. The patterns proved very difficult to recognize in the field, so that air photographs are essential for their study.

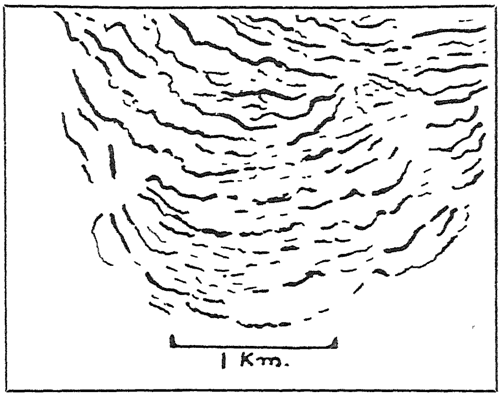

Diagram traced from air photo showing vegetation arcs at Gudubyero, Sawl Haud, British Somaliland, lat. 9° 44′ N., long. 48° 41′ E.

The vegetation arcs (see diagram) appear to be formed by the relatively rare rain storms, the water from which flows over this country of very low relief as a sheet, and not in incised water channels. It seems that accumulated organic debris, including seeds and also animal excreta (which is found in surprising abundance), are thus partially floated and carried along until for some reason not yet clear the load is deposited rhythmically in convex strand lines. Some of the seeds germinate and a vegetation arc is formed. This process appears to be repeated intermittently, and the arcs become firmly established features, practically all the vegetation of the semi-desert being concentrated in them. They include *Acacia* trees probably half a century old. The intervening ground, three or four times the width of the vegetation arcs, is kept almost completely bare.

As regards the scale, a single rhythm of vegetation arc and intervening desert averages about 160 metres, but may range from 70 m. to nearly 300 m.; the length of an individual arc is very variable, and may reach 2 km. or more.

The vegetation arcs are of practical value to the map-maker since they are invariably oriented with their convex sides directly up the slight slope, for which a preliminary value of *c.* 1 in 400 has been obtained. In fact, in some places they seem to form a rough approximation to naturally marked 'contours', with a vertical interval of the order of half a metre.

I suggest that this remarkable type of country, covered by tiers of these stable vegetation arcs, cannot at the present time be suffering appreciable soil erosion. Yet such country has been claimed as showing "severe erosion"; and Jacks and Whyte[3] have published an air photograph of it with the erroneous title "Wind erosion".

It is hoped to publish elsewhere a more detailed account of these and other vegetation patterns in the semi-deserts of Somaliland that are shown by the air photographs.

W. A. Macfadyen

Hope's Grove,
Tenterden, Kent.
June 23.

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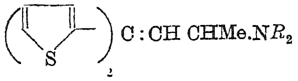
[1] Glover, P. E., "A Provisional Check List of British and Italian Somaliland Trees, Shrubs and Herbs" (London: Crown Agents for the Colonies, 1947. £4).

[2] "The Pastures of British Somaliland" (Aden: Cowasjee Dinshaw Press, 1947).

[3] Jacks, G. V., and Whyte, R. O., "The Rape of the Earth: a World Survey of Soil Erosion" (London, 5th Imp., 1947); see Fig. 14.

A New Series of Analgesics

A SERIES of potent analgesics, as active as morphine in the rat, has been discovered in the 3-tertiary-amino-1 : 1-(2′-thienyl)-but-1-enes (I). The analgesic toxicity ratios are not greatly different from that of amidone (II ; R = Me).


I

$CPh_2(COEt).CH_2\,CHMe.NR_2$

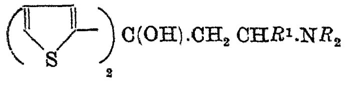
II

It is interesting that, as with other analgesics, the analgesia is accompanied by temperature and respiratory depression and by sedation in many laboratory animals, that an excitatory phase is manifest, particularly in the cat, and that high doses cause spasticity of the muscles and 'Straub tail' in rodents. The analgesic dose in dogs of compounds *a*, *b* and *d* is 5–10 mgm./kgm., as compared with 1–2 mgm./kgm. for amidone ; but the effect has not been accompanied by the gastro-intestinal disturbances which are common with amidone or morphine. The compounds also exhibit considerable antihistamine, spasmolytic and local anæsthetic activity.

Compound	Formula	Hydrochloride (m.p.)	Analgesic activity (P.95 limits)
a	I ; R=Me	169–170°	1·0 (0·87–1·2)
b	I ; R=Et	152–153	1·0 (0·83–1·1)
c	I ; $NR_2=N<[CH_2]_3>CH_2$	167–169	0·7 (0·58–0·84)
d	I ; $NR_2=N<[CH_2]_4>CH_2$	188–189	1·1 (0·97–1·3)
e	I ; $NR_2=N<[CH_2]_4>O$	181–182	0·3 (0·23–0 37)
Morphine	—	—	1·0 —

A limited analogy may be drawn between this and the amidone series, in so far as compounds of either series which lack the methyl side-chain are considerably less active. On the other hand, the morpholino group, which in the amidone structure (II ; $NR_2 = N < [CH_2]_4 > O$) promotes the highest activity in the rat[1], has an unfavourable effect in this series (compound *e*) ; however, this divergence may not be so marked in other animals.

It has recently been stated[2] that amidone falls into line with other synthetic analgesics in that its spatial atomic arrangement bears a close relationship to that of morphine ; but it is difficult to discern any such structural similarity between the compounds (I) and morphine.


III

The amino-butenes (I) were obtained by the dehydration of the corresponding amino-carbinols (III ; R^1 = Me), which were prepared by the action of 2-thienyl-lithium on the appropriate ethyl β-aminobutyrate. The amino-carbinols themselves are potent spasmolytics ; for example, the *in vitro* and *in vivo* activity of 3-N-piperidino-1 : 1-(2′-thienyl)-propan-1-ol (III ; R^1 = H ; $NR_2 = N < [CH_2]_4 > CH_2$; m.p. 70–72°, hydrochloride, m.p. 198° (decomp.)) is favourable in relation to synthetic spasmolytics now in clinical use. The amino-carbinols are also potent local anæsthetics.

This work forms part of a programme for the synthesis and pharmacological investigation of amino-alkyl tertiary carbinols and derived products, part of which is already described[3].

D. W. ADAMSON
A. F. GREEN

Wellcome Research Laboratories,
Beckenham, Kent.
Aug. 30.

[1] Attenburrow, J., Elks, J., Hems, B. A., and Speyer, K. N., *J. Chem. Soc.*, 510 (1949).

[2] Bergel, F., and Morrison, A. L., *Quart. Rev., Chem. Soc.*, 2, 381 (1948)

[3] Adamson, D W., *J. Chem. Soc.*, S 144 (1949).

Exchange in Cobalt Chelate Compounds

RECENT advances in nutrition chemistry have indicated the importance of co-ordination compounds in the uptake of cobalt by animals. With the advent of supplies of cobalt-60, obtained through the courtesy of the U.S.A.E.C., we in Adelaide have become interested in the possible exchange reactions between cobaltous ions and cobalt chelate compounds. Flagg[1], McCallum and Hoshowsky[2] have reported no evidence for exchanges of this type with a number of cobaltammines. However, Pauling[3] has pointed out that for co-ordination compounds the bond between the metal and its co-ordinated groups will be predominantly ionic if the compound exhibits a high paramagnetism, for example, 3–5 μ. It therefore appeared to us that exchange by an ionic mechanism should occur between metal ions and those co-ordination compounds of the metal which show high values of μ. Evidence for this theory has been presented by Johnson and Hall[4] in their work on the exchange of nickel derivatives with Ni^{++} ions.

The experimental procedure adopted in our work has been to mix solutions of chelate and cobalt sulphate, equimolal with respect to cobalt, and then to separate the two after various time intervals, by an extraction procedure. The tracer, cobalt-60, is always placed in the cobalt sulphate, and evidence for exchange is based on the appearance of activity in the chelate extract, activities being measured by a solution type, jacketed counter, holding 10 ml. Three extraction methods are employed : (1) water-soluble chelates are mixed with aqueous cobalt sulphate and the Co^{++} extracted as the thiocyanate complex with ether ; (2) pyridine-soluble chelates are mixed with aqueous cobalt sulphate and the chelate extracted with chloroform ; (3) insoluble chelates are shaken with aqueous cobalt sulphate, filtered off, dissolved in hydrochloric acid and counted. The following results are of interest (Table 1).

Table 1

Cobalt compound	Extraction	Temp.	μ [5]	Remarks
Disalicylaldehyde	(2)	20°	4·5	Complete exchange within 50 sec.
Guaiacol	(3)	20°	4·5	Steady exchange becoming complete in just over $2\frac{1}{2}$ hr
Trisethylenediamine chloride	(1)	20°	0	No exchange over 24 hr.
Disalicylaldoxime	(2) (2)	20° 45°	2·6	Slight exchange (see later)

Exchange has thus been found to occur where expected, for the salicylaldehyde and guaiacol derivatives, under the experimental conditions. The fact that the salicylaldehyde complex gives complete exchange almost immediately whereas with guaiacol the exchange is at a steady rate to eventual equilibrium, in spite of their similar susceptibilities, may be due in part to the experimental method. Exchange between a solid and a liquid would obviously be expected to be slower than exchange occurring when both substances are in solution. If the guaiacol complex were soluble, then immediate exchange might result (neglecting structural factors). For the ethylenediamine complex, diamagnetism suggests strong covalent bonding, and no exchange was observed, as had been predicted. In the case of the salicylaldoxime complex, a rather peculiar result has been obtained (Table 2).

Table 2. Cobalt salicylaldoxime: 5 ml. pyridine solution, 5 ml. cobalt sulphate solution (water), each, 1 mgm. cobalt/ml.

Temp.	Time (min.)	Water activity (made to 25 ml., 10 ml. sample)	Chloroform activity (made to 25 ml., 10 ml. sample)
20°	3	228·7 ± 2·0	20·0 ± 0·98
	6	223·0 ± 2·0	19·9 ± 0·93
	60	232·0 ± 2·0	18·3 ± 0·92
45°	10	220·7 ± 2·0	29·8 ± 1·0
	90	224·9 ± 2·0	32·7 ± 1·1
	240	220·5 ± 2·0	35·4 ± 1·1

At 20° the activity in the chelate layer remains constant within the probable error of counting over 1 hr., and at 45° seems to increase slightly over 4 hr. A 'blank' extraction with cobalt sulphate alone shows that chloroform extracts less than 0·01 per cent cobalt under these conditions; hence the activity cannot be due to retention of cobalt in the chloroform extract. Exchange had not been expected here, because of the low paramagnetism of the complex. The corresponding nickel compound[4] has, however, been shown to exhibit exchange in methyl 'Cellosolve'. Mellor and Willis[6] have shown that the solid, diamagnetic, nickel complex forms an octahedral complex in pyridine solution, giving the solution a high paramagnetism, and a similar complex formation in the case of the cobalt derivative may explain the observed results. Formation of a dipyridine salicylaldoxime complex may occur in solution, giving a mixture of planar salicylaldoxime and octahedral dipyridine complexes, one of which may be present in small amount. If this compound in small amount can undergo immediate exchange, then the appearance of the constant activity is accounted for, assuming the amount of that compound remains constant, over the time interval of the experiment. At 45°, more of the 'exchangeable' compound has probably formed; hence the slight increase in the amount of activity found in the chelate.

These investigations are being extended and a fuller account of the work will be published elsewhere.

B. West

Johnson Chemical Laboratories,
University of Adelaide.
Aug. 16.

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[1] Flagg, J. F., *J. Amer. Chem. Soc.*, **63**, 557 (1941).

[2] McCallum, K. J., and Hoshowsky, S. A., *J. Chem. Phys.*, **16**, 254 (1948).

[3] Pauling, L., "Nature of the Chemical Bond", 115 (2nd edit., Cornell University Press, 1948).

[4] Johnson, J. E., and Hall, N. F., *J. Amer. Chem. Soc.*, **10**, 2344 (1948).

[5] Values taken from Mellor, D. P., and Craig, D. P., *J. Proc. Roy. Soc. N.S.W.*, **74**, 495 (1940).

[6] Willis, J. B., and Mellor, D. P., *J. Amer. Chem. Soc.*, **69**, 1237 (1947).

X-Ray Irradiation of Polystyrene, Polythene and Paraffin Wax

It seemed desirable to compare the effects of X-ray irradiation of cellulose acetate already reported by N. N. Winogradoff[1] with the effects produced in other plastics.

Samples of polystyrene, polythene and paraffin wax measuring roughly 4 cm. × 5 cm. × 0·2 cm. were, in turn, laid over a 1·0-cm. circular aperture in a lead screen 0·3 cm. thick and irradiated through this aperture by radiation emerging from a 0·001-in. aluminium window of a 'Raymax' copper-target X-ray tube operated at 50 kVp., 30 m.amp. for periods up to 60 hr.

No evidence of brittleness of the irradiated patches was found. The X-ray diffraction patterns before and after prolonged irradiation showed no definite change in any of the structures.

As already reported by C. W. Wilson[2], on introducing the above samples into the X-ray beam, all three showed a definite bluish-white luminescence. After exposure of the order of 60 hr., the polystyrene and polythene samples showed a marked yellow-brown discoloration of the irradiated patch, and although no discoloration was observed in the paraffin wax sample, the irradiated patch was found to be more opaque than the rest of the translucent sample.

On removing the lead screen and irradiating the whole sample, the discoloured patch on the polystyrene sample glowed several times more brilliantly than the regions previously shielded from the X-rays; this glow persisted for a few seconds after removing the samples from the X-ray beam. Similar but much weaker effects were observed with polythene, but the persistence of the afterglow was of very short duration, if present at all.

Exposure of the samples to ultra-violet radiation from an 'Osira' black-bulb mercury-vapour lamp showed a very marked luminescence of the X-ray irradiated patches in the polythene and paraffin samples; but the patch in the polystyrene sample appeared to be almost black in comparison with the slight luminescence of the unexposed parts. On placing the polystyrene sample between the ultra-violet lamp and an anthracene screen, the slightly discoloured patch threw a very dark shadow on the screen, showing that prolonged exposure to X-rays produced strong absorption of ultra-violet radiation in polystyrene. This effect may have useful applications. Some ultra-violet fatigue effects were also observed.

This induced phosphorescence, discoloration, and the increased electrical conductivity of polystyrene on exposure to X-rays reported by F. T. Farmer[3], seem to show that the X-rays not only raise the electrons to the conduction band but also produce electron traps quite apart from any impurity centres which may have been present initially (see C. W. Wilson[2]). The ultra-violet absorption band indicates that the energy-levels of these induced electron traps are well below the conduction band.

I am indebted to the directors of Lansil, Ltd., for permission to publish this note.

N. N. Winogradoff

Research Laboratory,
Lansil, Ltd.,
Lancaster.
July 14.

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[1] *Nature* [**165**, 72 (1950)].

[2] Wilson, C. W., *Nature*, **161**, 520 (1948).

[3] Farmer, F. T., *Nature*, **150**, 521 (1942); *Brit. J. Rad.*, **18**, 148 (1945).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, January 23

Royal Geographical Society (at 1 Kensington Gore, London, S.W.7), at 5 p.m.—Prof. Gordon Manley: “The Changeability of the British Climate”.

Manchester Literary and Philosophical Society (in the Reynolds Hall, College of Technology, Manchester), at 5.30 p.m.—Symposium on “The Voluntary Social Services” *

University of London (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Prof. P. Grabar (Institut Pasteur): “Origin and Functions of Globulins and Antibodies”.*

Institution of the Rubber Industry, Manchester and District Section (at the Engineers' Club, Albert Square, Manchester), at 6.15 p.m.—Mr. K. W. Hayes: “Some Aspects of the Stability of Compounded Latex”.

Institution of Electrical Engineers (at the Great Western Hotel, Reading), at 7 p.m.—Dr. T. E. Allibone, F.R.S.: “Trends of Development in Atomic Energy”.

Tuesday, January 24

British Psychological Society, Industrial Section (in Room 105, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 1 p.m.—Mr. J. A. Purser: “Introducing a Psychological Approach to Management”.

Royal Anthropological Institute (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Dr. Madeline Kerr: “Culture Contact and Conflict in Jamaica”.

Royal Society of Arts, Dominions and Colonies Section (at John Adam Street, Adelphi, London, W.C.2), at 5.15 p.m.—Mr. E. Bruce Levy: “Grasslands in the Commonwealth”.

Eugenics Society (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. C. A. B. Smith: “Fitness and Survival”.*

Plastics Institute, London and District Section (at the Waldorf Hotel, Aldwych, London, W.C.2), at 6.30 p.m.—Symposium on “Synthetic Finishes”.

Society of Dyers and Colourists, Manchester Section (at the Textile Institute, 16 St. Mary's Parsonage, Manchester), at 7.15 p.m.—Mr. G. K. Mecklenburgh: “The Dyeing and Finishing of Nylon Textiles”.

Wednesday, January 25

Physical Society, Optical Group (at the Northampton Polytechnic, St. John Street, London, E.C.1), at 3 p.m.—Dr. W. D. Wright: “The Role of Convergence in Stereoscopic Acuity”; Mr. L. P. C. J. Dudley: “Auto-Stereoscopic Photography”.

Royal Society of Medicine, Endocrinology Section (at 1 Wimpole Street, London, W.1), at 5 p.m.—Dr. A. S. Parkes, F.R.S.: “Hormone Assays on Body Fluids” (Presidential Address).

Royal Meteorological Society (at 49 Cromwell Road, London, S.W.7), at 5.10 p.m.—Annual General Meeting; Sir Robert Watson-Watt, F.R.S.: “The Evolution of Meteorological Institutions in the United Kingdom”.

University of London (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. E. Orowan, F.R.S.: “The Mechanical Strength of Solids”.* (Further Lectures on February 1 and 8.)

Institute of Welding (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Mr. W. K. B. Marshall: “The Welding of Light Alloys in Structural and Similar Applications”.

Society of Chemical Industry, Nutrition Panel of the Food Group (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.15 p.m.—Dr. W. F. J. Cuthbertson: “The Vitamins—Up-to-date Review”.

Royal Statistical Society, Birmingham Group of the Industrial Applications Section (in the Chamber of Commerce, 95 New Street, Birmingham), at 6.30 p.m.—Mr. W. A. Bennett: “Statistical Quality Control Applications”.

Royal Institute of Chemistry, Dublin and District Section (in the Department of Chemistry, University College, Dublin), at 7.45 p.m.—Dr. E. C. Knight: “Chemical Activities of Micro-Organisms”.

Thursday, January 26

University of London (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Prof. G. R. de Beer, F.R.S.: “Embryos and Ancestors”.*

Society of Antiquaries of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. D. A. E. Garrod: “Excavation in an Early Magdalenian Rock-Shelter at Angles-sur-l'Anglin in the Vienne”.

Royal Statistical Society, Sheffield Group of the Industrial Applications Section (in Room B.1, The University, St. George's Square, Sheffield), at 6.30 p.m.—Miss J. Keen: “Statistics and the Craftsman”.

Society for Visiting Scientists (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Discussion on “Genetical Factors in the Study of Anthropology”. (Speakers: Dr. A. E. Mourant, Mr. N. A. Barnicot and Dr. H. Lehmann.)

Friday, January 27

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Geophysical Discussion on “Glaciology”.

Royal Statistical Society (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Prof. M. G. Kendall: “Factor Analysis as a Statistical Technique”; Mr. B. Babington Smith: “An Evaluation of Factorial Analysis from the Point of View of a Psychologist”.

Institution of Mechanical Engineers (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Dr. T. W. F. Brown: “Some Factors in the Use of High Temperatures in Gas Turbines”.

Television Society (at the C.E.A., 164 Shaftesbury Avenue, London, W.C.2), at 7 p.m.—Mr. R. C. Mildner: “High Frequency Cables in Television”.

Chemical Society, Glasgow Section (at the Royal Technical College, Glasgow), at 7.15 p.m.—Prof. F. S. Spring: “Recent Advances in the Chemistry of the Steroids”.

Saturday, January 28

Nutrition Society (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 10.20 a.m.—“Commonwealth Contributions to the British Diet”.

British Psychological Society, Scottish Branch (in the George Combe Psychological Laboratory, The University, Edinburgh), at 2.30 p.m.—Symposium on “The Scottish Mental Survey, 1947” (Speakers: Sir Godfrey Thomson, Mr. James Maxwell and Mr. D. Kennedy-Fraser).

London County Council (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Dr. C. J. Hackett: “The Aborigines of Central Australia” *

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Head of the Electricity Section, Defence Research Laboratories, Melbourne, and a Superintending Geophysicist in the Bureau of Mineral Resources, Geology and Geophysics, Melbourne—The Australian Munitions Representative, Canberra House, 85–87 Jermyn Street, London, S.W.1 (January 26).

Head of the Department of Physics and Mathematics, and a Head of the Department of Chemistry—The Registrar, Birmingham Central Technical College, Suffolk Street, Birmingham 1 (January 28).

Lecturer in Physics at the Coventry Technical College—The Director of Education, Education Offices, Coventry (January 28).

Physicist, and a Chemist, for work concerned with various aspects of the manufacture and properties of knitted products—The Secretary, Hosiery and Allied Trades Research Association, 4 First Avenue, Sherwood Rise, Nottingham (January 28).

Chemist or Physicist (Rubber Technologist) for the organisation of rubber testing, laboratory and research on testing methods, a Chemist (Chemical Engineer) for research on unit processes applied to the preparation of plantation rubber, a Chemist (Biochemist) for research on the constituents and enzymology of latex, a Chemist (Analyst) for the organisation of analytical laboratory, a Chemist (Physical Chemist) for the study of rubber as a high polymer, a Chemist (Colloid Chemist) for research on the colloidal properties of latex, a Botanist (Plant Physiologist) for research on the physiology of latex formation in the growing plant, a Micro-Biologist for the study of microbiology of soils under cultivation with *Hevea* with particular reference to the nitrogen cycle in tropical soils, an Agricultural Engineer or Soils Chemist with research experience in problems of mechanical cultivation, and a Statistician for the design of experiments, research in statistical methods and their application, at the Rubber Research Institute, Kuala Lumpur, Malaya—The Secretary, London Advisory Committee for Rubber Research (Ceylon and Malaya), Imperial Institute, London, S.W.7.

Chief Technical Engineer (with honours degree) to take charge of an engineering section responsible for all the major calculations involved in the design and construction of factories for producing fissile material, a Chief Power Services Engineer to be responsible for the design and lay-out of all steam and electrical services for large factories, a Deputy Chief Instrument Engineer to be responsible for the provision and adaptation of instruments for the Division's factories, a Planning Engineer to undertake the construction planning of a large factory, and an Electrical Engineer to be responsible for electrical installation design work on large factories with grid intake—The Administrative Branch, Ministry of Supply, Division of Atomic Energy (Production), Risley, near Warrington, Lancs.

Lecturer in Physiology—The Secretary, King's College of Household and Social Science, Campden Hill Road, London, W.8.

Metallurgist (with degree in metallurgy or equivalent qualifications) for the application of research results to industrial practice—The Secretary, British Non-Ferrous Metals Research Association, Euston Street, London, N.W.1.

Metallurgist to take charge of Metallurgical Development Laboratories, and a Development Engineer to assist in the operation of a prototype plant and to co-ordinate the results for major design purposes, at the Ministry of Supply Division of Atomic Energy (Production), at Springfields Factory, Preston—The Administrative Branch, Ministry of Supply, Division of Atomic Energy (Production), Risley, near Warrington, Lancs.

Research Assistant for work relating to analysis and testing of coal and the products of its combustion, and a Research Officer (with B.Sc. or equivalent in mechanical or chemical engineering) for experimental work relating to industrial combustion equipment—The Assistant Secretary, British Coal Utilisation Research Association, Randalls Road, Leatherhead, Surrey.

Research Officer, Ebini Livestock Station, British Guiana, to undertake duties involving the planning and supervision of research and other projects at the Station for the purpose of ascertaining the most economic methods of developing the minerally deficient savannahs of the area—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

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TECHNOLOGICAL EDUCATION IN BRITAIN

IN an article on "University Development" contributed to the *Political Quarterly* of July–September 1949, Mr. Kenneth Lindsay stressed particularly the need for considering more closely the selection of students and the re-statement of purpose in the light of modern scientific developments. He pointed out further that, while the State has some responsibility for seeing that certain national needs in trained men and women are met, those basic needs could conceivably be multiplied to a point which would necessitate a definite number of students being trained at government expense. "A university policy which concerned itself solely with meeting basic national needs would quickly degenerate into a narrow professional outlook and the whole conception of a university would be changed within a decade. It is one thing to pay regard to the absorption capacity of the professions, but quite another to base the university curricula on such a straitened and closed conception of national welfare."

These comments of Mr. Lindsay are brought to mind by the publication of the first five reports[*] from the sub-committees appointed by the Technical Personnel Committee of the Ministry of Labour and National Service to examine the probable supply and demand for persons with professional qualifications. Happily, these reports remove any fears that, on the score of demand, the universities will be deflected, so far as most scientific subjects are concerned, from their hitherto accepted purposes; and in that respect the reports are unlikely to shift the general consensus of opinion in Great Britain from its strong support of the maintenance of quality and standards as against a merely quantitative conception of university development. The central issue which the reports raise is rather that of where technological or professional training should be given—in the universities or in professional or technological institutions.

That point did not escape Mr. Lindsay in his article, for he noted that although the Percy Report was published five years ago, no action has yet been taken to develop technical colleges into institutions of university status. Since then, the question of technological education and university studies has received a considerable amount of attention. The broad question of arrangements for education in technology was discussed in the second report of the Advisory Council on Scientific Policy. A contribution of Prof. M. L. E. Oliphant, "University or Institute of Technology?", to the symposium on "The Mission of a University" in the *Universities Quarterly* of November 1949, the report on "University Reform in Germany", published for the Foreign Office during the autumn, which has a chapter on "Technical Universities", are pertinent to the debate. There have also been discussions before the Institute of Physics and the Institution of Electrical Engineers on the education and training of technologists, and before the Institution of Mechanical Engineers on the provision of technological courses in universities, technical colleges and national colleges. These discussions were preceded by a report on the education and training of technologists issued by the Institute of Physics in March 1948, while aspects of the same subject were also considered at a conference, held during November 25–28, of representatives of all British universities and of industry convened by the Federation of British Industries through its Education and Industrial Research Committee. A session of the Conference of the Universities of Great Britain and Northern Ireland on December 17 and 18, 1948, considered the selection of students more particularly in the light of the report of the 'working party' on university awards, and the report of that Conference, published last autumn*, contains some reference to the training of technologists, particularly in the discussion which followed Sir Ronald Weeks's paper on university graduates in commerce and industry. The whole question of technological education and its relation to the universities of Great Britain was considered much more fully at the Conference of the Home Universities held during December 16–17 (see *Nature*, January 21, p. 104).

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[*] Ministry of Labour and National Service: Technical and Scientific Register. Present and Future Supply and Demand for Persons with Professional Qualifications: in Architecture, pp. 20, 6*d.* net; in Chemistry, pp. 24, 6*d.* net; in Electrical Engineering, pp. 24, 6*d.* net: in Geology, pp. 16, 4*d.* net: in Physics, pp. 32, 6*d.* net. (London: H.M. Stationery Office, 1949.)

The question of numbers is of vital importance in arriving at a proper balance between the universities and the technical colleges, and the five reports from Lord Hankey's Committee appear at a time when the need for economy may well lead those outside the universities to be more sharply critical of expansion proposals. Of the five reports, only that relating to the supply of chemists suggests that over the next five years there is likely to be a considerable deficit against demand. Even here, however, the Sub-Committee does not consider that any further expansion of training facilities is to be recommended. It pays tribute to the universities for implementing already the recommendations of the Barlow Report and providing for the training of chemists in numbers which are more than double those of the pre-war years. These increased numbers, it is satisfied, are not in excess of those quickly to be required in the years ahead, and the hope is expressed that where the universities are using temporary facilities for the purpose, those facilities will be put on a more satisfactory basis as early as possible.

The first fact that stands out from these reports is that the universities have already provided for the expansion asked by the Barlow Report, and that in some subjects such as physics the expansion in some universities has been not double but four-fold. In some of them there is a marked note of reservation as to the maintenance of quality, not so much on the score of the ability of the students entering the universities, as on the effect of over-crowding and improvised conditions on the quality of the teaching. A "Report on University Expansion", adopted last May by the Council of the Association of University Teachers and published in September, refers to this aspect more specifically. But although the report on the supply of electrical engineers mentions the need for improved facilities for the further training of technicians at technical colleges, neither in that report nor in any of the others is the issue of the distribution of students between the universities and the technical colleges considered.

Some pointers, indeed, are to be found. A good deal of stress is laid on the question of quality in relation to geologists, and on the importance of a broad basis in their training. The shortage of really good physicists for research is specially stressed, as well as the many openings for physicists who find the final parts of the university courses beyond their powers, and for what are termed in the report 'physicist-engineers'—men with a physics degree but also the practical outlook of the engineer and anxious to apply their knowledge of physics to industrial problems. The sub-committee on the supply of chemists refers also to complaints that too many of those undertaking postgraduate training are encouraged to regard scientific research as the only worth-while career for a chemist; and it suggests that university departments should endeavour to see that both research and process needs are met adequately and appropriately.

Apart from the reservation, in the report relating to chemists, that the position should be reviewed again in three years, the reports so far issued confirm the impression that university expansion has already proceeded far enough to meet the recommendations of the Barlow Report in respect of science subjects, and that the universities are already able to provide the nation with the predictable requirements of graduates in science and technology generally. Whether that is entirely true of technologists, at any rate in particular fields, is less certain. That the conditions under which the universities have for the most part expanded has prevented them from making the most of the students admitted is scarcely open to doubt. There is the further major question whether the universities have not admitted many students who should not have been trained at a university at all, but in the technical colleges.

That, of course, is the central issue in the discussions of the training of technologists which have followed the appearance of the Percy Report, but it has been somewhat obscured by a further discussion on what is really a particular aspect—postgraduate training in technology. Confusion really arises because insufficient serious attention has been given to the fundamental questions on the answers to which the reorganisation of technical education in Great Britain in relation to the universities really depends. A recent P E P Broadsheet, "University Courses", is to be welcomed for the clarity with which it frames these main questions: What is it that distinguishes (or should distinguish) university study from study in other institutions of higher education? What type of young men and women are capable of profiting from this kind of study? And how should they be selected for admission to a university? It is in the light of answers to these questions that we should proceed to consider the further question whether existing university courses are those best suited to the studies and students desired. Only then can we really consider what additional provision should be made for higher education in non-university institutions, and whether the problem can be solved by expanding existing institutions and increasing their numbers, or whether we need new institutions of a type hitherto unknown in Great Britain.

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* Report of the Proceedings of the 1948 Conference of the Universities of Great Britain and Northern Ireland. Pp. 125. (London: Association of Universities of the British Commonwealth.) 1*s*.

The note on "Technology in Universities" which has just been issued by the University Grants Committee (London: H.M. Stationery Office. 4*d.* net) does not take this matter much further. The University Grants Committee is satisfied that technologists should form part of the student body, and that it is to the advantage of industry that some of its technologists should have been educated in universities in contact with students drawn from a wide variety of faculties. It recognizes that in some faculties of engineering an increase in the facilities for research is desirable, and also agrees that postgraduate activities in the field of technology should be extended to include some postgraduate instruction as distinct from research. These suggestions, however, appear to rest essentially on pragmatic grounds, and in the brief note advancing them there is, doubtless for reasons of space, no indication of the fundamental implications of the situation.

The view that, generally speaking, industry is not receiving a sufficient number of highly trained technologists, which, as Dr. D. S. Anderson pointed out to the Institution of Mechanical Engineers on December 2, has been asserted specifically at the last two meetings of the British Association and elsewhere, has rarely led to the consideration of these primary questions; and the nine questions on which Dr. Anderson invites discussion are really secondary and would be readily answered once the answers to the primary questions had been obtained. Prof. H. W. Swift went nearer to the fundamental issue in suggesting that a university undergraduate course should develop in the young technologist an understanding of physical science and an ability to apply this science to practical problems over a wide range. The acquisition of special technological material data is an essential part of his training as distinct from his education, and accordingly is more directly the responsibility of industry. Moreover, this is in accordance with the weight of the evidence that most employers to-day, in considering the type of men required for posts of responsibility, look, as Sir Ronald Weeks emphasized in his paper before the Home Universities Conference, not for mere academic brilliance or attainment alone, but rather, in addition, for the powers of leadership, quickness of decision and the ability to see a job through to its finish.

While such views may well influence a university in deciding whether or not to include particular courses of study, they do not provide the real criteria by which to decide whether or not a subject is fit for inclusion in a university course. The University Grants Committee in its last report went some way in that direction; but the universities might well go further in conference towards the elaboration for public guidance of a clear statement of the criteria by which their judgments in this matter are formed. Political and Economic Planning in its broadsheet suggests tentatively four tests which could be applied: the subject of itself must raise problems of general interest; it must be based on an established body of knowledge; its study must provide an intellectual training; and it must demand a certain degree of initial preparation on the part of those pursuing the study. University students must have had a suitable educational preparation and have shown proof of intellectual ability.

It will be obvious that these tests will scarcely help to resolve the present conflict of opinion as to whether the expansion of technological education should take place within the walls of the universities or by the expansion of the technical colleges and the creation of new types of institution for technological education. On both sides there are those who recognize that technological education, like a university course, at its best involves the presentation and study of knowledge in a form which raises in the mind of the student certain general or fundamental problems. These problems are posed in terms of the particular subject which he is studying—and should arise naturally out of his ordinary course without being injected or superimposed by artificial or deliberate devices. It should also be made clear to the student that similar problems arise in other fields of study, and he should be brought to appreciate that they are, at the deepest level, perennial and ubiquitous, requiring severe mental discipline and scrupulous integrity for their solution.

Education of this type must be associated with the advancement and consolidation of knowledge, and that is why the university has the twin inseparable functions of research and teaching. Any qualitative defects of the technical colleges of Great Britain may well be traced to the comparatively insignificant extent to which research has hitherto been associated with their teaching functions. Quantitatively, the defect may be due not so much to deliberate neglect of research as to the high cost of technological research, given the system under which technological education has hitherto been administered. Indeed, it has been suggested by Prof. A. R. Ubbelohde that technological education should be separated from the universities not because it is unsuitable for a university but because a different type of administration is desirable for advanced technological studies. Among engineers, current opinion appears to hold that technical training should be distinct from technological training, and that before a technological education is begun fundamental education such as is now provided by degree courses should be concluded. While it may be less generally agreed that technological and professional education should be imposed on a university education and not provide a parallel or alternative, it is important that the distinction between technical and technological training should be more widely recognized. Confusion on this point has been responsible for much disagreement.

SCIENCE AND LEARNING IN THE FOURTEENTH CENTURY

Introduction to the History of Science

Vol. 3: Science and Learning in the Fourteenth Century. By Prof. George Sarton. (Carnegie Institution of Washington, Publication 376.) Part 1. Pp. xxxiii+1018. Part 2. Pp. xiv+1019–2155. (Baltimore, Md.: Williams and Wilkins Co.; London: Baillière, Tindall and Cox, 1948.) £5 10*s.* 0*d.* net.

ALL will learn with regret that Prof. George Sarton regards this as the last volume he will be able to complete of his "Introduction to the History of Science", which was originally planned to reach the year 1900. But at least we can be thankful that he has been able to complete that part of the plan which covers the period—the twelfth to the fourteenth centuries—to which the greater part of his own researches have been devoted. The author estimates that, omitting unconscious or casual preparation, some twenty-seven years of work are represented in this last volume. It is no surprise, therefore, to discover the great wealth of information that has been collected in its 2,000-odd pages. What is more important, the information has been sifted, criticized and presented with great erudition and a wonderful breadth of scholarship.

The two halves of the fourteenth century receive one part apiece. The book is to be used as a reference work. Only two introductory chapters, one for each half-century, surveying more briefly and connectedly the material which is to follow, are intended for consecutive reading; and to me even these savoured more of the reference work than of the account intended to be 'readable'.

The greatest virtue of this work is certainly the breadth of its outlook. Virtually all peoples, all languages and all religions which have any relevance to the history of knowledge in the period receive attention—and, of course, every branch of science, as well as historiography, law, sociology and philology, which are not usually included in science in the English-speaking world. One finds seven pages on the life and labours of William of Occam, two pages on the mosaics of St. Saviour in Chora, five on treatises on military technology, two on Japanese medicine, a description of the Chinese census of 1370 together with a reproduction of the official instructions therefor, a paragraph on Buddhist atomism—these random selections obtained by flicking the pages must serve to indicate something of the variety of topics covered.

The book is brought up to date as at May 1947 by means of 41 pages of addenda; and in addition Prof. Sarton provides, through the columns of *Isis*, a continuous service of further addenda and errata. There is a bibliography of 40 pages, as well as numerous other bibliographical references in the text or in footnotes. There are three indexes: a general index (subject and author) of 174 pages, 8 pages of Greek index and 53 pages of Chinese index. That would seem to be more than adequate, and yet it was precisely in the index that the book seemed to me to be most deficient as a reference work. Under 'humanism' only three pages are indexed; they lead to one bibliographical item and two minor paragraphs; yet the work abounds in references to humanism which go unindexed, among them 14 pages (502–16) on Petrarca and five sections amounting to nearly 10 pages (1288–97) on humanism in various European countries. Four pages (217–21) on mining and metallurgy are not indexed under either heading. I noticed many other similar omissions. There are some peculiarities, too, in the arrangement of the text—the reader must be aware that topics are not always treated where they might be expected; he will miss a lot unless he is prepared to follow up every possible cross-reference.

Not even Prof. Sarton can do everything, and for the potential reader it is perhaps as important to know what the book does not cover as what it does. Prof. Sarton's definition of science as "systematized, positive knowledge" allows him to include historiography, law, sociology and philology among the sciences. But it also implies restrictions. The emphasis throughout the book is on knowledge rather than the obtaining of knowledge (that is, method). The author is usually more interested in what a man knew, thought, believed or wrote than on how he reached his conclusions. He says (p. 17) that "Special pains have been taken to explain the emergence of the experimental point of view". I have no doubt that the material for doing so is contained in the book; but the arrangement does not permit of easy access to it. There is almost no discussion of method (experimental or other) as such; and the index gives little help—one reference each for "experimental method" and "experimental point of view" (many important references to these are not indexed), four to "causality, principle of" (all on philosophical rather than scientific approaches to the question) and none to such headings as "teleology", "observation" and the like, which would be very useful to the student interested mainly in methodology.

The definition of science as "knowledge" rather than "knowledge-and-power" (the Baconian view) also tends to restrict the scope of the book. Technology, though not neglected, is rather sketchily and disconnectedly treated, and (with a few exceptions such as some parts of chemistry) the treatment is but little integrated with the discussions of fundamental science. It is perhaps the same limitation that leads to the very full treatment of the religious, philosophical and cultural background and, in contrast, the almost complete omission of the social, economic and political background. Prof. Sarton agrees (p. 37) that "Political and economic factors are obviously important; we might even say that they are fundamental". But he leaves them to the reader to deal with, giving only 19 pages of "General Background", which treat general history (mostly political) in a rather superficial way, and some incidental references to particular social influences on particular scientific events but without any attempt at a general integration of scientific and social history. Indeed, it is in political and social matters only that I would dare to make criticisms of commission rather than omission. Few historians would agree that "waves of socialism were spreading over Western Europe in the fourteenth century" (p. 13); and to say that medieval thought overcame national boundaries (p. 78) is to give an entirely wrong emphasis, for at that time national boundaries had scarcely begun to exist.

All these points, however, are not so much criticisms as definitions of the limitations of this work. Limitations are not a disadvantage provided the reader is aware of them, and so does not seek in the book things which it does not pretend to contain. On those conditions he will find little to complain of in Prof. Sarton's crowning achievement. S. LILLEY

IDENTIFICATION OF ZOOPLANKTON

Conseil Permanent International pour l'Exploration de la Mer

Fiches d'identification du zooplankton, Nos. 1–17. Publiées sous la direction de Dr. P. Jespersen et F. S. Russell. Pp. 74. (Copenhague: Andr. Fred. Høst et fils, 1949.) 10 kr.

ACTING on a recommendation made by its Plankton Committee in 1939, the International Council for the Exploration of the Sea has started to issue a series of identification sheets for the zooplankton of the north-western Atlantic. The object of this venture is admirably summarized by Dr. P. Jespersen and Mr. F. S. Russell in their editorial note. "These sheets are not intended to be short cuts to identifications, but they are to prevent unnecessary waste of time and possible introduction of errors of identification by plankton workers, who cannot be specialists in every animal group. The valuable Nordisches Plankton is now out of date for many groups, and it is difficult for a worker to make sure that all the latest literature on each group has been seen. Accordingly these sheets can be regarded as up-to-date guides on the present position in each group with references to the best literature for identification. Since they are issued in loose leaf form it is hoped that it may be possible to issue amendment sheets to keep them up to date." On seeing the sheets one feels confident that this, and more, will certainly be achieved.

So far, seventeen sheets are available, covering the Chætognatha, Cladocera, Appendicularia, Thaliacea, Ostracoda, and, in part, the Hydromedusæ, Pteropoda and Copepoda; also we have been told by the secretary-general of the International Council that the following are now in the press: ten on Copepoda including one on their nauplii, two on the Hydromedusæ and twelve on the Mysidæ. We may hope that other important ones will soon follow, particularly those on the euphausians, the pelagic larvæ of molluscs, the fish eggs and fish larvæ. These sheets have, in every case, been prepared by a leading authority and, thanks to the excellent format selected, compress a wealth of data into a conveniently small space. The salient points of a concise and essentially practical key are illustrated by line drawings, and references are given to the best works on the description and systematics of each species. A table gives the known distribution of each species in the area, and there is a selected bibliography on the distribution and ecology of every group.

These sheets will not only be of value to planktologists and other marine biologists who have less frequent reason to resort to detailed identification, but also, and particularly so, to the student of invertebrate morphology and the less-experienced worker to whom the subject may be comparatively new. These latter will discover that the bibliographies have been expertly chosen, and that by using them it is possible to become familiar with the various plankton groups without the confusion and discouragement which may well arise from the many contradictory statements to be found if the literature is read without guidance.

The identification sheets should certainly be available in every library. Then, as the series grows, the worker who wishes to recognize his plankton will become well equipped. The expert will have beside him an up-to-date guide to the literature and readily available data to aid his memory, while the student and the less experienced will be able to select the detail he requires without difficulty or waste of time. Biologists will frequently have reason to be grateful to the International Council, the editors and the many contributors for introducing this excellent source of information.

K. M. RAE

THE INERT GASES

Handbuch der analytischen Chemie

Herausgegeben von R. Fresenius und G. Jander. Teil 3: Quantitative Bestimmungs- und Trennungsmethoden. Band 8a: Elemente der achten Hauptgruppe, Edelgase: Helium, Neon, Argon, Krypton, Xenon, Radon und Isotope. Bearbeitet von H. Kahle und B. Karlik. Pp. xii+120. (Berlin, Göttingen und Heidelberg: Springer-Verlag, 1949.) 19.60 D. marks.

METHODS of separating or determining different elements of this group have much in common, since they are based mainly on the same chemical property of inertness and on differences in physical properties such as volatility, density and refractivity. It is not surprising, therefore, to find that the practice hitherto adopted in the "Handbuch" of dealing with each element separately has been largely abandoned in the present volume in favour of a more general treatment.

Except for a short description of special procedures, including sampling and measurement of the gases, the scope of the book is strictly confined to methods of detection, separation and quantitative determination. The bulk of the subject-matter, contributed by H. Kahle, is arranged under three main headings: (1) determination of the total content of inert gas in a mixture; (2) methods of determining separate inert gases in an inert gas mixture; and (3) individual treatment of inert gases, classed as light (helium, neon), medium heavy (argon) and heavy (krypton, xenon, radon). The book concludes with a separately indexed section (twenty-one pages) by B. Karlik dealing with radon and its isotopes, thoron and actinon.

The methods are drawn from work published up to 1941 and, in some cases, from unpublished work of H. Kahle himself. A wide field of analysis is covered; but the treatment does not aim at being exhaustive. Rather, a selection is made of the more important methods, particularly with regard to the requirements of industry, for example, the testing of argon and neon for the traces of impurities harmful to their use in electric lamps and neon signs. Methods important in fundamental research, including micromethods, also receive attention, and among the more recent developments reference is made to the work of O. Hahn and F. Strassmann on the separation and determination of minute traces of radioactive krypton and xenon from uranium fission. Descriptions of some of the methods are brief, but are well supplemented by references to original papers.

Features of the book are the methodical arrangement of the subject-matter and the profusion of line drawings. Because of its essentially practical value, the volume will appeal particularly to the laboratory worker.

WORLD MORPHOLOGY OF IONOSPHERIC STORMS

By Sir EDWARD APPLETON, G.B.E., K.C.B., F.R.S., and W. R. PIGGOTT
Department of Scientific and Industrial Research

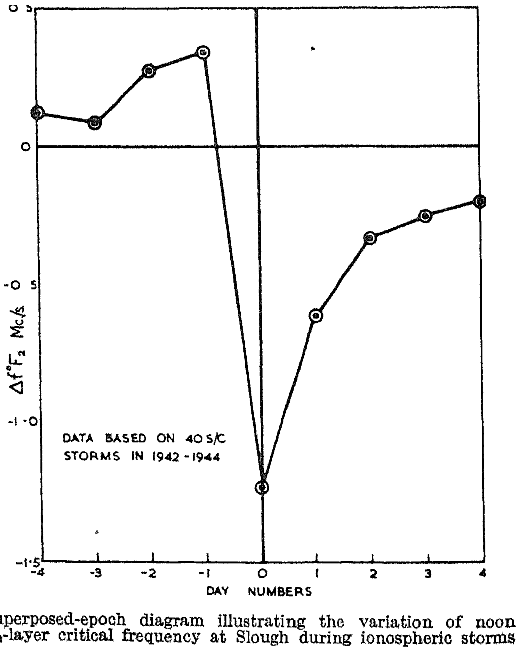
IT has been known now for some years that there is a fairly intimate connexion between geomagnetic storms and ionospheric disturbances. During and since the International Polar Year of 1932–33, a good deal of evidence has been accumulated which has demonstrated certain features of this connexion in high and medium latitudes. The most striking of these is the marked depression of the maximum electron density of the F_2-layer during enhanced geomagnetic activity, a correlation established during ionospheric soundings made at both Tromsø (lat. 69·6° N.; long. 18·9° E.) and Slough (lat. 51·5° N.; long. 0·6° W.). Nevertheless, there have also been noted certain features in the radio evidence which have indicated that this simple inverse correlation between F_2-layer critical frequency and geomagnetic storm index does not apply uniformly at all times or for all locations on the earth's surface. Appleton and Ingram[1], for example, found at Slough that, while the F_2-layer critical frequency (f^0F_2) was, on the average, reduced during geomagnetic storms, there were to be noted certain occasions when f^0F_2 was definitely above normal during storm conditions; while, later, Berkner and Seaton[2], from a statistical study of ionospheric results at the equatorial station of Huancayo (lat. 12° S.; long. 75° W.), showed that the value of f^0F_2 for this station actually increased with increase of geomagnetic activity. In a recent study of the world morphology of ionospheric storms, we have found it possible to reconcile these apparently conflicting results. Such an extended study of ionospheric events, as regards both time and place, has been made possible by the institution of a network of ionospheric stations throughout the world for the collection of basic data to be used in ionospheric forecasting.

The reconciliation of the conflicting results mentioned above can perhaps best be approached by reference to the accompanying graph, which exhibits the results of a statistical study of ionospheric data from the Radio Research Station, Slough. Days of major depressions of f^0F_2 associated with geomagnetic storm conditions were taken as zero days, and the average departures (Δf^0F_2) of f^0F_2 from monthly mean noon values were calculated both for zero days and for a number of days before and after (superposed-epoch method). Here it will be seen that, for two days before the major departure (depression) from the monthly mean value, the critical frequency of the F_2-layer was significantly above the average. After the major depression the recovery to normality is seen to be slow. The graph illustrates the starting point of our inquiry, for it shows that, at Slough, which may be considered a typical temperate latitude station, an ionospheric storm has a positive phase (that is, $\Delta f^0F_2 > 0$) as well as the well-known negative phase ($\Delta f^0F_2 < 0$), and that the positive phase precedes the negative phase. We have called this type of perturbation a 'biphase disturbance'.

Very similar results have also been obtained for other stations at temperate latitudes in both the northern and southern hemispheres. If, however, we attempt to use the same procedure for an equatorial station, we find that there are comparatively few occasions when there is a sudden drop in f^0F_2 for selection, and the resultant curves drawn are not consistent. If, however, we draw for an equatorial station a superposed-epoch curve for the storm days selected for a temperate latitude station on the same longitude, it is found that the equatorial station experiences a quite well-marked positive phase which roughly coincides in time with the temperate zone negative phase.

Variation of Ionospheric Storm Manifestation with Latitude

The results described above may now be incorporated in some more general statements concerning the results of the study of the variation of ionospheric storm manifestations with latitude. Taking high-latitude stations first, we may say that we have confirmed the results obtained during the International Polar Year relating to the association between geomagnetic storminess and F_2-layer critical frequency depressions. At such stations we have not encountered a positive ionospheric phase during a geomagnetic storm. With the onset of geomagnetic disturbance, the critical frequency of the F_2-layer drops, and recovers during day-time as soon as the violent perturbations of the geomagnetic field subside. Indeed, the quick recovery to normality of the F_2-layer when the geomagnetic storm abates is most noticeable, and suggests that such recovery is controlled chiefly by the relaxation time of the layer, which is normally of the order of one or two hours.



Superposed-epoch diagram illustrating the variation of noon F_2-layer critical frequency at Slough during ionospheric storms

We propose to refer to such quick-recovery phases, which are characteristic of auroral-type conditions, as 'Q.R. negative phases'. The study of individual storms shows that Q.R. negative phases in the F_2-layer are more closely associated with the rate of change than with the amplitude of the geomagnetic field.

As we have seen above, a different type of ionospheric storm manifestation is often encountered at temperate latitudes, in that we obtain the positive–negative phase sequence. It is found that the major geomagnetic disturbance usually occurs during the earlier part of the biphase sequence, and it frequently happens that conditions are geomagnetically quiet during the slow negative phase. As is illustrated in the graph for Slough, the recovery in the negative phase may occupy up to three days; and for that reason we propose to call it, by contrast with the auroral-type phenomena, a 'slow-recovery (S.R.) negative phase'. We have noted, occasionally, ionospheric storms in temperate latitudes exhibiting a marked positive phase which has not been succeeded by a negative phase at all. The great geomagnetic storm of February 7 and 8, 1946, was, for example, associated only with a positive ionospheric phase at Slough, though Q.R.-type negative phase effects were observed at Washington (lat. 39° N.; long. 77° W.). This illustrates the fact that Washington behaves more like an auroral-type station than does Slough, although its geographical latitude is lower than that of Slough.

As we proceed from temperate latitudes towards the equator, we find the S.R. phase of an ionospheric storm becoming less pronounced; so that, at an equatorial station such as Huancayo, only the positive phase is experienced. As mentioned above, the full development of the positive phase at an equatorial station is usually delayed until the associated negative phase at temperate-latitude stations is near its maximum.

Ionospheric Accompaniments of Sudden-Commencement Geomagnetic Disturbances

In a closer study of F_2-layer variations at individual stations, we have found most remarkable ionospheric changes to accompany 'sudden-commencement' geomagnetic disturbances. On many such occasions we have noted a rapid depression of f^0F_2, followed immediately by a short positive phase. This quick depression, which we have detected only in data from temperate and higher-latitude stations, is often missed in hourly routine ionospheric measurements since it seldom lasts longer than half an hour. We believe, however, that it usually occurs on the sunlit side of the earth when the S.C. disturbance is large.

Influence of Ionospheric Storminess on F_2-Layer Variability

Although the day-to-day variations of the general day-time level of F_2-layer ionization are found to be similar for closely adjacent stations, the correlation of the variations of day-time f^0F_2 between a pair of stations falls rapidly as the distance between the stations is increased. This suggests that the variations of f^0F_2 from day to day are not, in general, due to variations in the intensity of the solar ionizing radiation; otherwise we should expect variations to be similar over the sunlit hemisphere. (It should be mentioned, however, that we have noted a single occasion, at a time of sunspot minimum, when a single spot occurred on the sun's disk and when the ionization densities of the E-, F- and F_2-layers increased simultaneously at all stations on the sunlit hemisphere.)

We are of the opinion that ionospheric storm phenomena contribute substantially to the general F_2-layer variability. As has been shown, quite different signs (positive or negative) of f^0F_2 deviation may be experienced at stations of the same longitude and different latitude. Moreover, we have found that the extent of ionospheric storms is usually surprisingly limited in longitude. As there is also a marked diurnal control of ionospheric storm manifestation, we usually find little correlation between the simultaneous variations of f^0F_2 at stations of similar latitude when they are separated by more than 60° in longitude. A further cause of the lack of uniformity in F_2-layer variability is that ionospheric storms are seldom equally developed in the northern and southern hemispheres, uni-polar storms being more frequent than bi-polar storms.

The general type of response of a given station to ionospheric storminess is certainly more nearly correlated with magnetic than with geographic latitude, though even in the former case the connexion is only rough. Washington, for example, mostly behaves like an auroral-zone type of station, whereas Burghead (lat. 58° N.; long. 3° W.) and Leningrad (lat. 60° N.; long. 30° E.) are predominantly non-auroral-type medium-latitude stations, although all three lie on the same magnetic latitude.

The work described above was carried out as part of the programme of the Radio Research Board and is published by permission of the Department of Scientific and Industrial Research.

[1] Appleton and Ingram, *Nature*, **136**, 548 (1935).

[2] Berkner and Seaton, *Terr. Mag.*, 419 (Dec. 1940).

INSTITUTE OF BIOLOGY

THE first general meeting of the Institute of Biology was held at King's College, London, on January 5, 1950, and attended by more than 150 biologists, representing most branches of the subject. The chair was taken by Dr. Edward Hindle, who opened the meeting with a brief review of the stages which had marked the formation of the Institute.

In April 1946 the Council of the Association of British Zoologists decided to call a meeting, which should be representative of professional biologists in all branches of the subject, to give further consideration to the possibility of founding an Institute of Biology. At this meeting, held in May, it was unanimously agreed that such a professional Institute was desirable, and the Biological Council was requested to explore the matter further and formulate proposals.

The Biological Council met in October, but could not agree that the demand for an Institute had been proved. Dr. J. F. Danielli, Dr. E. Hindle and Dr. C. B. Williams were therefore asked to consider the matter in greater detail and prepare a report.

This report was put before the Biological Council in May 1947, redrafted, and finally approved in March 1948. In the autumn of that year more than eight thousand copies were printed and circulated to biologists through the various biological societies. By February 1949 more than 750 replies had been received in support of an Institute, and the Biological

Council appointed a sub-committee (with Dr. Hindle as chairman) to proceed with its formation.

This sub-committee issued invitations to a number of eminent biologists to join a provisional council, which held its first meeting on October 28, 1949. Prof. J. F. Danielli and Dr. R. J. C. Harris were appointed respectively to the office of honorary secretary and assistant secretary for the period ending October 1, 1950. The Provisional Council also arranged the general meeting, and agenda and forms of application for admission were sent in December to all those who had indicated their support for an Institute.

After his opening remarks the chairman declared the meeting open to discussion and various proposals were put forward for consideration.

With reference to the composition of the Council, Dr. T. Goodey felt that applied biologists were not as fully represented as they should be. Dr. G. Pontecorvo proposed that a geneticist should be included, and other speakers wanted a Scottish regional representative. The chairman agreed that the present Council was not fully representative (for example, no palæontologist was a member) and the meeting unanimously accepted the proposal of Dr. H. R. Hewer that the Council should be given the power to co-opt.

The meeting agreed that the Provisional Council should be confirmed as the first Council of the Institute, that it should be empowered to further the aims and objects of the Institute as determined by the meeting, and that it should hold office until the close of the annual general meeting in 1951. Dr. Hindle was unanimously elected president of the Institute and chairman of the Council, which is constituted as follows: Dr. Edward Hindle (*chairman*), Prof. J. F. Danielli (*honorary secretary*), Prof. T. A. Bennet-Clark, Prof. G. E. Blackman, L. J. F. Brimble, Dr. D. G. Davey, Captain Cyril Diver, Dr. J. W. Evans, Prof. A. Graham, Prof. J. Gray, Prof. A. Haddow, Dr. J. Hammond, Dr. C. Horton Smith, Prof. W. H. Pearsall, N. W. Pirie, and F. S. Russell.

The general aims and objects of the Institute were next discussed. The meeting agreed that these should be: (*a*) the provision of a representative body of biologists; (*b*) the elevation of the profession of biologist and the advancement and diffusion of a knowledge of biology, pure and applied, and especially (i) to promote the efficiency and usefulness of its members by setting up a high standard of professional and general education and integrity; (ii) to establish and maintain a benevolent fund; (iii) to keep an appointments register; (iv) to form local and overseas branches; (v) to provide a central office and meeting-place.

In view of the considerable interest in the Institute already shown by biologists in many parts of the Commonwealth, Dr. J. W. Evans devoted special attention to (*b*) (iv). The Council, he stated, was anxious to make definite provision for the differing requirements of home and overseas biologists, and if, as was hoped, large numbers of the latter joined the Institute, overseas branches would be desirable. Obviously, the first job was to complete the establishment of the parent body; but the Council hoped that both overseas and local branches would develop in the future and, by their activities, make worthwhile contributions to the progress of the parent Institute.

Prof. J. F. Danielli then opened a discussion on conditions of membership. The memorandum outlining a proposed Institute had had a wide circulation among biologists, and the suggested recommendations concerning grading of membership (into ordinary members and fellows) had been much criticized. The Council now proposed that, at least until the next general meeting, qualified professional biologists should be admitted into one category only. This proposition and a further suggestion, requesting the Council to examine the feasibility of a student membership for prospective full members, were accepted unanimously. It was further agreed that all applications for membership (and every professional biologist, whether a university graduate or not, is invited to apply) should be dealt with by the Council.

Prof. Bennet-Clark stressed the fact that a professional Institute was not, and could not act as, a trade union; but it was not debarred from taking an interest in the financial, as well as the professional, interests of all its members. The sister Institutes of Chemistry and of Physics had already obtained data concerning the salary structure of their membership in relation to age and type of employment. It would be desirable to make an early and similar assessment of this structure for the profession of biology, in order that comparison might be made with the sister professions, and that data should be available for the use of the envisaged appointments register. The meeting agreed that the Council should be empowered to conduct a suitably safeguarded salary census in conformity with the practice of other Institutes.

It was further agreed that the Council should consider the desirability and practicability of compiling a register of biological consultants similar in function to that already in existence in chemistry. Such a register might also define the scope of such consulting work, lay down standards and formulate a code of practice, with regard to advertising and standardization of fees.

The meeting concluded with a unanimous expression of thanks to the Biological Council, the Society for Experimental Biology and the Biochemical Society for their financial assistance, and to those biologists, especially Prof. J. F. Danielli, who had devoted so much effort to the founding of the Institute.

Further information concerning the Institute can be obtained from the Assistant Secretary, Institute of Biology (at the temporary office), Chester Beatty Research Institute, The Royal Cancer Hospital, Fulham Road, London, S.W.3.

SNOW FLORA OF THE SCOTTISH HILLS

By SETON GORDON, C.B.E.

LITTLE has been written of the so-called perpetual snow-beds of the Scottish mountains and of the vegetation which grows—exists rather than flourishes—near them. There are two well-known snow-fields which almost always remain unmelted throughout the year. One of them is on Braeriach, one of the Cairngorm hills, and the other is on Ben Nevis, which, standing near the west coast, is the highest mountain in Great Britain. Larger than either of these two at the beginning of summer is the field of snow which lies north-east of the summit of Ben MacDhui, 4,296 ft. in height; but this great snow-field, being exposed to the disintegrating effects of the wind, usually disappears by the autumn. Unlike the two other snow-fields, it is visible from afar, and I believe in favourable conditions can be seen from vessels on the North Sea.

The snow-bed on Braeriach and that on Ben Nevis lie at, or near, the 3,600-ft. level; both face north-east, and both are almost entirely screened from every wind that blows. It is to their sheltered position that they owe their long life, for a strong, mild wind in summer melts snow faster than the hottest sun; these snow-beds are screened from sun as well as from wind. The plants which grow at the margins of the snow-fields are usually beneath the snow from November until July. Nearer the heart of the snow-fields their emergence is progressively for a shorter period, until, at the extreme margin of the zone which supports plant life, they may be covered with snow from late in one October until early in the October of the following year.

The climber who approaches the great snow-field at the head of Garbh Choire Mor of Braeriach on a day of mid-summer sunshine cannot but be impressed by the cold snow-field, brilliantly illuminated by the sun for a short time around mid-day, and the warm sun-bathed slopes near it, where already *Silene acaulis* and *Saxifraga stellaris*, with other plants, are in full bloom. He passes, in effect, in a few hundred yards from mid-summer conditions to those of mid-winter or earliest spring. At mid-summer the snow-bed is still so extensive as to exercise a considerable influence on the climate near it. I have been on the plateau of Braeriach in June when a local gale, with wind-speed exceeding sixty miles per hour, has swept the plateau, its origin being the great snow-field in the depths of the Garbh Choire 500 ft. beneath. As I have fought my way to the edge of the plateau I have felt the temperature fall, as though a cloud had obscured the sun, and have been stung by small stones lifted from the ground by the force of the gale. The sensation under such conditions which one experiences standing perhaps a quarter of a mile (in a straight line) from that great snow-field is similar, or at least calls to mind, that experienced when approaching the ice on the Greenland Ocean off the South Cape of Spitsbergen.

Let me describe first the vegetation which appears, and almost at once begins to grow, as the Braeriach snow-field gradually melts, and, later, that of the Ben Nevis snow-field, cradled high above the brackish water of Atlantic sea lochs in Lochaber. As one approaches the Braeriach snow-bed—the usual approach is by the Garbh Choire from Glen Dee, but it may be reached by climbing Braeriach from Aviemore and descending into the corrie just to the westward of where the Dee drops in a series of waterfalls from the Braeriach plateau—one walks upon a carpet of ling (*Calluna vulgaris*) with, here and there, a few small juniper bushes with highly aromatic wood and, on dry granite ridges, that small hardy plant with pink china-like flowers, *Azalea procumbens*. This small plant in summer beautifies the high hills of Norway, Switzerland and other European countries.

As the climber approaches the snow, he notices that ling, juniper and the creeping azalea are left behind—the growing season is too short for them. He reaches the snow, let us say, in early August. At its margin plants are being daily released from the snowy covering. Various species of hill grass and *Carex* lie brown and flattened by the weight of snow which for months has held them prisoners. The grasses seem devoid of life. Among the plants *Alchemilla alpina*, the alpine lady's mantle, is seen to be sending out small green leaves, as yet rolled up; when released from the snow, this plant is swifter in growth than any grass. Here and there among the screes, the parsley fern (*Allosurus crispus*) is unrolling its green fronds, and that plant of ancient lineage, the club moss (*Lycopodium selago*), badge of the wild MacRaes and of the proud MacKenzies, seems to have lost none of its freshness after its nine-month imprisonment.

If the observer should return to the snow-bed at the beginning of September, he may find summer conditions still prevailing, or he may see fresh snow lying on the Arctic plateau of Braeriach, where, at 4,000 ft. above sea-level, the climate resembles that of Spitsbergen rather than of Scotland, and where an early September snowstorm is not so infrequent as might be imagined. He will notice that the old snow-field has considerably receded during the month of August and that, where the snow has recently melted, small plants of cudweed (*Gnaphalium supinum*) and of *Saxifraga stellaris* are beginning to grow. At a little distance from the snow the grasses are beginning to flower. In mid-October he will see that *Saxifraga stellaris* has small flower-buds, and that a few plants of *Gnaphalium supinum* have flowered and may even have formed seeds. Yet in an average season, at mid-October these plants have but ten days more of activity before the new snow covers them afresh.

If the autumn be mild and snowless, the climber may return to the snow at the beginning of November (yet even in 1949, after the exceptional summer and autumn, new snow had fallen before the close of October) and will then find the snow-field at its lowest ebb. He will see that *Saxifraga stellaris* has been unable to flower, for its growth has been checked by the severe frosts which prevail there on clear nights in October. Yet even in November he is likely to see moss covering the ground and the rocks to the very edge of the snow. From my observations of this snow-bed during most autumns since 1908, I have found there are cycles when this moss may remain hard-frozen beneath the snow for the space of some half-a-dozen years, without loss of vitality. At the close of this prolonged imprisonment the plants have perhaps no more than a fortnight when it is possible for them to grow before they are again covered, and during that fortnight the weather may be cold, with long nights of frost. It is remarkable that the mosses are able to remain alive under these unfavourable conditions.

There are years when a warm summer following a mild winter causes the snow-bed to shrink to small dimensions, yet I have never seen it disappear. It was, for example, confidently predicted that the snow would be found to have gone by mid-October 1949; but the place was visited only three days before the snow of autumn again covered this high corrie, and a small snow-field, a sheet of ice rather than of snow, with a depth of approximately 2½ ft., still remained. During these exceptional years—and I have known three of them since 1908—the rocks and boulders at the edge of the snow give the impression that they have recently fallen from the cliff above, for they lack the normal growth of moss and lichen.

If we except the mosses, the plant found nearest to the snow at its lowest ebb is *Saxifraga stellaris*. This plant is evidently able to maintain life if it has even a short growing period; it would be interesting to know whether under these conditions it lives for a greater number of years than those of its race which grow freely, and perhaps exhaust themselves producing seed. The water trickling from the snow-bed provides the damp environment favourable to it. One may unexpectedly find a small colony of harebells (*Campanula*) beneath the rocks perhaps two hundred yards from the snow-bed, but outside its normal influence. Snow-buntings are often seen near the snow; and for some years a blue hare had its home there, and my collie dog habitually put the animal up from boulder-strewn ground at almost always the same place. The animal may have found *Gnaphalium supinum* (a favourite plant with sheep) to its liking.

Fifty miles by air westward from Braeriach lies Ben Nevis, where a snow-field lies almost always unmelted beneath a high precipice which falls from the hill-top to the north-east. The surroundings of the snow-bed are sunless, dark and gloomy, and the rainfall there greatly exceeds that on Braeriach. The rocks which rise almost sheer above this snow-bed are higher than those which shelter the Braeriach snow-bed from the winds. I have mentioned that on Braeriach the sun in summer does shine for a time upon the snow, but I doubt if the Ben Nevis snow-field is lit up by sunshine at any time. The steep screes, which are unstable and easily provoked into a slide, are unfavourable to plant life, and with the exception of mosses and lichens on the stones there is no plant near the edges of the snow-bed except *Saxifraga stellaris*, which grows luxuriantly, although it has no time to form flowers. Its presence here is not without interest, as its seeds are almost certainly carried by the wind, perhaps also on the drifting snow during winter blizzards, from the edge of the plateau far above, where is to be found, at an elevation of 4,300 ft., the highest colony of this saxifrage in Britain. Indeed, the colony may be the highest of any phanerogam in the British Isles.

This account may fittingly be ended with a brief note on the possibility of perpetual snow existing in Britain. There are, as I have stated earlier, only two snow-beds which might be thought to be relics of the snow of the Ice Age. One of them is on Ben Nevis, the other on Braeriach. There have been rumours that in two years recently, when a mild winter was followed by a warm summer and autumn, the Ben Nevis snow-bed had disappeared. On Braeriach, it was reported to me that, about the year 1935, the snow had gone also. Yet when the Braeriach bed shrinks to its lowest ebb, it may well escape notice, as it recedes into a 'pocket' and becomes discoloured and ice-like in character. Indeed, on one occasion I reached a neighbouring 'pocket' and found it free of snow for the first time in my experience; and even then I was unable to see the bottom of the main 'pocket', although I was only a few yards from it. To my surprise, I found that the second 'pocket' still contained snow. There is, therefore, a possibility that this snow-bed is permanent; if so, it is the only perpetual snow in the British Isles.

Certain Highland families traditionally hold their land on the condition that they are able to supply the King with a bucket of snow whenever he should pass that way. The Camerons of Glen Nevis, the Grants of Rothiemurchus, and the Munros of Foulis are all supposed to hold their lands on this condition.

CHEMICAL ASPECTS OF ATOMIC ENERGY

On November 9 a symposium on "Chemical Aspects of Atomic Energy" was held in the University of Manchester. The meetings were arranged by the Manchester local section of the Chemical Society, in conjunction with the Society of Chemical Industry and the Royal Institute of Chemistry, and papers were presented by members of the staff of the Atomic Energy Research Establishment.

In an introductory lecture, Dr. R. Spence (head of the Chemistry Division, Atomic Energy Research Establishment, Harwell) gave a broad survey of the role of the chemist in the atomic energy programme, and of the facilities for chemical research that have been set up at Harwell. After reviewing the development of the chemical effort from the time of the Tube Alloys Project, through the international co-operation at Montreal and later at the National Research Council laboratories at Chalk River, Ontario, he outlined the present organisation. In addition to the short-term problems that arise from the technological side of the work, there is need for a wide variety of fundamental research. Shorter-term work at Harwell includes technological investigations, the development of methods for extracting radio-isotopes of high specific activity and very high purity from materials irradiated in the British piles, and an extensive range of unusual analytical problems. For longer-term work, research groups are working in the fields of physical chemistry, with particular reference to ion exchange and the properties of concentrated solutions of electrolytes; radiochemistry, especially on problems related to the fission products; radiation chemistry (equipped with a 2-MeV. Van der Graaf generator, for producing monochromatic γ- and β-radiation) and inorganic chemistry. The interests of these groups were reflected in the other papers of the symposium. As the chairman, Dr. F. Fairbrother, stated in his opening remarks, the work of the chemist enters in at every stage of pure and applied nuclear studies.

The place of the trans-uranic elements in the Periodic Table was discussed by Dr. J. S. Anderson. It has been unambiguously established that neptunium and plutonium have no similarity to rhenium and the platinum metals; we may infer that they belong to a transition series in which $5f$, rather than $6d$, electron-levels are being filled. We have to weigh the physical and chemical evidence to decide at what atomic number the $5f$-levels first become tenanted, and to assign configurations to the known elements up to curium ($Z = 96$). Spectra of the heavy elements are complex; but Kiess and Meggers have assigned to uranium the ground-state $5f^3 6d 7s^2$. Americium is said to have a simpler spectrum resembling europium; this would point to the ground-state $5f^7 7s^2$. The absorption spectra (for example, of U^{IV}, Pu^{VI}, Pu^{IV}) rather resemble those of the rare earths and are suggestive of 'forbidden' transitions between $5f$-levels. The magnetic moments of ions with effective atomic number ranging from 86 to 92 (Ac^{3+}, Th^{4+}, U^{6+}, Am^{3+}) show a regular trend resembling that in the rare-earth series, but quantitative evaluation is not yet possible. Chemically, the most stable valence state changes regularly from uranium (U^{6+}), through neptunium (Np^{5+}), plutonium (Pu^{4+}) and americium (Am^{3+}) to the apparently constant trivalency of curium. 'Horizontal' relationships are clear between the oxy-cations UO_2^{2+}, NpO_2^{2+}, PuO_2^{2+}, and between the tetravalent states of all elements from thorium to plutonium or americium. Marshalling evidence from the solution chemistry and crystal chemistry of the halides, oxides, sulphides and phosphides of the heavy elements, with special reference to recent work on the lower valencies of thorium and the complex intermediate oxide phases of uranium, Dr. Anderson suggested that the following tentative conclusions can be drawn: thorium is the true analogue of zirconium and hafnium, that some 5*f*-levels are already tenanted in neutral uranium, and that the analogy of curium to gadolinium rests on suggestive, but incomplete, evidence. The practically unknown chemistry of protactinium leaves a gap at a most interesting point, and it is to be hoped that this may be remedied during the next few years.

Dr. E. Glueckauf, in a paper on the physical chemistry of solutions of uranyl nitrate, presented some new results on the constitution of such solutions and their partition equilibria with non-aqueous solvents. With solutions of concentration up to $2M$, the activity coefficient of uranyl nitrate is higher than that of nitrates of other bivalent cations, but at higher concentrations association to $[UO_2(NO_3)]^+$ and $[UO_2(NO_3)_2]$ occurs very markedly. The solutions are unique in the high partition coefficients for distribution of uranyl nitrate between water and esters, ethers, ketone and alcohols. In each type of solvent the solubility increases regularly with the oxygen/carbon ratio, irrespective of the nature of the solvent —for example, ordinary ethers derived from aliphatic or cyclic radicals, poly-ethers (such as dibutyl cellosolve) or cyclic ethers such as dioxane. Moreover, while the partition coefficients of nearly all divalent nitrates, between water and dibutyl tetraglycol, fall (on a relative scale) between 1 and 100, that of uranyl nitrate is 10^5–10^6. In ethyl ether the difference is still greater, partition coefficients of cobalt nitrate, copper nitrate, and uranyl nitrate being in the ratio 1 : 2 : 10^7. In the organic solutions, uranyl nitrate is mainly undissociated electrolytically and takes with it four molecules of water; the dissolved entity is $[UO_2(NO_3)_2(H_2O)_4]$. This information enables the partition equilibria in concentrated organic solutions to be treated quantitatively. From the organic solutions, solid complex compounds $[UO_2(NO_3)_2(H_2O)_3(S)]$ and $[UO_2(NO_3)_2(H_2O)_2(S)_2]$ (S = solvent molecule) have been isolated, and it is reasonable to formulate the known ammonium uranyl double nitrate as $(NH_4)_2\ [UO_2(NO_3)_4(H_2O)_2]$. In the solid hexahydrate and its aqueous solutions, the complexes $[UO_2(H_2O)_6](NO_3)_2$, $[UO_2(NO_3)(H_2O)_5](NO_3)$ and $[UO_2(NO_3)_2(H_2O)_4]$ probably exist. The $[UO_2(NO_3)(H_2O)_5]^+$ ion differs in absorption spectrum from the $[UO_2(H_2O)_6]^{2+}$ ion, suggesting that the nitrate ion may be covalently bound. The mechanism of such covalent binding, and of the remarkably strong solvation of the neutral complex by organic molecules, cannot be stated with certainty: Dr. Glueckauf outlined some hypotheses consistent with the present evidence.

Mr. F. Morgan described recent advances in the chemistry of fission products, as shown in published American, Canadian and British work. One problem is that of the fission yield—the fraction of fissions giving rise to a particular mass number—in the different types of fission available for study. The yields of nearly all mass chains in the fission of uranium-236* (from the uranium-235 – slow-neutron reaction) are now accurately known, though the distribution of nuclear charge is the subject of active work at Harwell and elsewhere. The shape of some fission yield curves are now well known; the ratio of the symmetrical mode of fission of uranium-235 to the most probable, asymmetric mode is about 1 600; with uranium-233 and plutonium-239, asymmetric fission by thermal neutrons is also favoured. With sufficient deformation, most heavy nuclei undergo fission. Thus thorium-232 (threshold 1 MeV.) has been studied with different neutron energies; the ratio of symmetrical fission to most probable mode rises from 1/100 for neutrons of 2 MeV. to 1/15 for neutrons of 13–19 MeV. A similar increase in symmetrical fissions is found by comparing the processes ^{232}Th + high-energy α-particle → $^{236*}U$, with $^{235}U + {}^{1}_{0}n$ (thermal) → $^{236*}U$. Finally, in the fission of bismuth-209 with 200-MeV. deuterons, the yield curve has a single symmetrical peak about mass 99–100; the lighter fragments have a neutron excess, the heavier fragments being neutron-deficient (α-active) or stable. Knowledge of the neutron-capture cross-sections of fission products is important for the economic operation of piles. Such measurements involve either successive neutron-capture processes—the yield being measurable only if exceptional neutron fluxes are available—or the isolation of the fission products in carrier-free state. Physicochemical methods of separation—for example, by solvent extraction or ion-exchange processes—are particularly suitable, and lend themselves to use in shielded apparatus at high levels of activity. Individual rare-earths as well as the new elements 61 (promethium) and—especially interesting—43 (technetium) can be isolated from fission products by these means.

The last paper, on chemical effects of radiation, was given by Dr. W. Wild, under the chairmanship of Prof. M. G. Evans. The use of materials in and around the structure of a nuclear reactor is limited by radiation damage, while detailed studies of chemical effects are needed to provide the physicochemical background of biological studies. In a pile, fission fragments and β-radiation are largely absorbed within the fissile material, but moderator, coolant and structural material are subject to the effects of γ-radiation and fast neutrons. The primary effect of radiation is to excite or ionize molecules, the ejected electrons causing secondary ionization until they are slowed down and captured. The positive ion (A^+) may then undergo either decomposition (into radicals or stable molecules), reaction with other molecules, exchange of charge or neutralization by collision with a negative ion. Hence, the primary act of excitation may initiate a series of chemical changes. The radiation decomposition of water is an important reaction of this type, leading on long irradiation to evolution of hydrogen and oxygen, and the maintenance of a stationary concentration of hydrogen peroxide. The current view is that the initial process furnishes H_2O^+ and electrons; the former react ($H_2O^+ + H_2O \rightarrow H_3O^+ + OH$) to give hydroxyl radicals, and the electrons lead ultimately to liberation of hydrogen—$e + H_2O \rightarrow H_2O^-$, $H_2O^- \rightarrow OH^- + H$. In the absence of solutes, hydrogen and hydrogen peroxide result ($2H \rightarrow H_2$, $2OH \rightarrow H_2O_2$); but in a closed system a stationary state is reached in which the back reaction proceeds by a chain mechanism—$OH + H_2 \rightarrow H_2O + H$, $H + H_2O_2 \rightarrow H_2O + OH$. In the presence of dissolved oxygen, hydrogen atoms react to form more hydrogen peroxide. These reactions, and the effects of oxidizing and reducing ions in solution, can now be correlated with other studies of oxidation – reduction processes. In ionic solids, highly ionized atoms resulting directly from the collision of fast neutrons lose most of their energy by electronic excitation, but near the end of their track they must suffer elastic collisions. Atomic displacement and the rupture of chemical bonds thereby result, and the physical properties of solids are modified. A third field of radiation chemistry is in the study of 'hot-atom' chemistry—the ultimate chemical fate of atoms formed, often with high recoil energies, in nuclear reactions. To this category belong Szilard–Chalmers processes, and the formation of hydrogen cyanide, carbon monoxide and carbon dioxide, containing carbon-14, during the neutron irradiation of ammonium nitrate.

J. S. ANDERSON

OBITUARIES

Dr. A. E. V. Richardson, C.M.G.

THE death occurred in Melbourne on December 5, at the age of sixty-six, of Dr. A. E. V. Richardson, who for the last forty years has given distinguished service to the agricultural and pastoral industries of Australia. Born in Adelaide, Dr. Richardson's connexion with agriculture began when he was a student at Roseworthy Agricultural College. He studied science at the University of Adelaide, where he graduated M.A., B.Sc. In 1909 he was appointed assistant director of agriculture in South Australia, and in 1911 transferred to the Victorian Department of Agriculture as superintendent of agriculture. The purpose of his appointment was to put the activities of the Department on a scientific basis, and this was realized to the full. Richardson threw himself into his work with tremendous energy, and changed the whole basis of departmental advice from 'expert' opinion to the results of carefully planned experiments. He reviewed the scope of the State research farms and consolidated their work into three main stations: the Experiment Farm at Rutherglen, where work on the top dressing of pastures led to the establishment of subterranean clover throughout Victoria; the Central Research Farm at Werribee, working on cereal breeding; and Longerenong Agricultural College, which was responsible for the introduction of improved cultivation methods of wheat farming. As a result of his work, new wheat varieties were developed and many improvements made in wheat farming practice. Wheats developed from Werribee now represent 86 per cent of the acreage sown to this crop in Victoria. His publication "Wheat and its Cultivation" became a standard text on the subject in Australia, and for this work and research on the water requirements of farm crops he received in 1924 the first D.Sc. degree awarded in agriculture by the University of Melbourne.

In 1918 Richardson visited the United States and Canada for the Victorian Government to study agricultural education and research; as a result of his report on this visit, the School of Agriculture was established on its present basis at the University of Melbourne, and Richardson was appointed dean of the Faculty and director of the School. He held these posts in addition to his position with the Department of Agriculture, and thus ensured a close link between the educational and research activities of the University and the requirements of the Department for research and extension workers.

In 1924, Mr. Peter Waite, a prominent South Australian pastoralist, presented his estate on the outskirts of Adelaide, together with a considerable endowment, to the University of Adelaide, which, as a result, was able to establish the Waite Agricultural Research Institute and the Waite chair of agriculture. Richardson accepted an invitation to be first director of the Institute and occupant of the chair, and his energy, enthusiasm and devotion to the problems of agriculture found full scope in his new post. He was responsible for the development and expansion of the activities of the Waite Institute to its present leading position among the agricultural research institutes of Australia. In 1927 Richardson was appointed a member of the Executive Committee of the newly formed Council for Scientific and Industrial Research, a position he held until his retirement in 1949, and there is no doubt that his skilful judgment and wide knowledge of Australian agricultural problems contributed largely to the early success of the Council in selecting problems for research which yielded such valuable results for Australian primary industries. In 1938 he left the Waite Institute to become deputy chief executive officer of the Council for Scientific and Industrial Research, and in 1946, on the retirement of Sir David Rivett, he was appointed chief executive officer, a post which he held until his retirement in 1949. In 1927 Richardson was a delegate to the first Imperial Agricultural Research Conference in London and in 1932 an official adviser to the Australian delegation to the Ottawa Conference. He was created C.M.G. in 1932. He was the first president of the Australian Institute of Agricultural Science in 1935, and in 1947 was president of the Australian and New Zealand Association for the Advancement of Science. His presidential address, "Science in Relation to Australia's Development", is a brilliant survey of the possibilities of research in Australia.

Richardson was a big man, in mind and stature, and his genial, unassuming manner won him warm friends in many walks of life. Apart from his work he had wide interests, especially in the arts and in various games, in which he possessed greater than average ability. He had an encyclopædic knowledge of agricultural matters and a prodigious memory for facts and figures which made him a formidable opponent in argument. As well as his ability as an experimentalist and his unfailing judgment of the practical value of research, he possessed a capacity for solid work and careful attention to detail which made him such a successful administrator. He is survived by his wife and daughter.

Prof. W. H. Newton

PROF. WILLIAM HENRY NEWTON, professor of physiology in the University of Edinburgh, died on December 20, after an illness of a few months. His all-too-early death makes a grievous gap in the ranks of British physiology.

Newton was born in 1904, the son of the Rev. J. T. Newton, and educated at Ashville College, Harrogate, and at the University of Manchester, taking first-class honours in physiology at the B.Sc. examination in 1925. After a further year he took the M.Sc. degree, and continued physiological studies (on plain muscle) during the succeeding three years, which were occupied chiefly in qualifying in medicine. He then became a house physician at the Manchester Royal Infirmary, but finally was launched as a physiologist by being appointed to the Sharpey Scholarship in physiology at University College, London, in 1930. It was at University College that he spent the largest part of his academic life, as lecturer, senior lecturer (1933), and finally as a reader during 1937–44. He was sub-dean of the Faculty of Medical Sciences for several years. During 1937–38 he worked at Yale University as a Rockefeller Fellow, and further extended his knowledge and his circle of friends. During the war years 1939–44 he was acting head of the Department, and, despite unstable health, administered it with tact and wisdom in the difficult conditions imposed by evacuation and by the strain of war.

In 1944 Newton was appointed to the Holt chair of physiology in the University of Liverpool, effected fundamental improvements there, and was very happy. Nevertheless, when invited to the chair at Edinburgh in 1948, he accepted, though with some hesitation. A major factor in deciding him was his wish to rejoin Prof. G. F. Marrian, with whom he had collaborated in earlier years. At the time when his appointment began, the preclinical syllabus was being re-planned, and he gave himself wholeheartedly to assist in this undertaking.

Newton was elected a member of the Physiological Society in 1930, and served it with characteristic zeal and loyalty, as a member of Committee (1941–43 and 1948–49), as a secretary during 1943–47, and as a valuable member of the editorial board of the *Journal of Physiology* during 1948–49. He relinquished the last-named position in order to become chairman of the editorial board of the *Quarterly Journal of Experimental Physiology*. His last communication to the Physiological Society was given by a collaborator only three days before he died.

Newton worked in various fields in physiology: but the subject which he made his own was that of reproductive endocrinology. He showed that many of the phenomena of pregnancy persisted, in some species, after removal of the fœtus, if the placenta remained, and that it could sometimes persist after removal of the ovaries: the placenta, as these observations showed, had important endocrine functions.

Newton was a completely sincere and strong character, a writer of wit and charm, and withal a sensitive and modest personality. He was self-critical, patient and completely dependable in all ways. His "Recent Advances in Physiology" bore witness to some of his fine qualities, to his wide knowledge and interests, his high critical faculties, and to his literary abilities. His department was a happy and a united one, and he will be long and affectionately remembered. He married in 1931, Stella, daughter of Mr. Roger Reynolds, and his family consists of two daughters.

C. LOVATT EVANS

NEWS and VIEWS

Electrical Engineering at University College, London: Prof. R. O. Kapp

AT the end of the present University session, Prof. R. O. Kapp retires from the Pender chair of electrical engineering which he has held at University College, London, since 1935; his successor will be Prof. H. E. M. Barlow, professor of electrical engineering in the College. Prof. Kapp entered academic work from consulting engineering practice, in which he had been concerned particularly with the technical problems of a number of large-scale electricity supply systems, including the North-West and North Wales sections of the British Grid. He took to University College a wealth of experience on the needs of the professional engineer, and with it considered views about the best way in which to direct academic training towards meeting those needs. Apart from important and valuable innovations in the teaching of engineering science, he has been instrumental in establishing at University College, as a regular part of the undergraduate course, training in applied economics, law for engineers and the study of the presentation of technical information. His book, dealing with the last of these subjects, and the wide interest which this and his lectures have stimulated, are examples of the enthusiasm which he has given to this work and of the response it has engendered. Prof. Kapp has also devoted unremitting energy to the affairs of the University of London as a whole. For the past four years he has been dean of the University Faculty of Engineering, and a member of the Senate. In this capacity he has played a vital part in the solution of many difficult post-war problems. Prof. Kapp's breadth of knowledge is remarkable. It extends far beyond the horizon of most of those engineers who in other respects may stand comparison with him, and includes languages, music and philosophy. His book entitled "Science and Materialism" reveals unsuspected depths of thought well outside ordinary spheres. By his teachings and his personal influence, Prof. Kapp has made a profound contribution to educational work, both inside and outside the University of London.

Biochemistry at University College, London: Prof. E. H. F. Baldwin

LONDON will be the gainer and Cambridge the loser by the appointment of Dr. Ernest Baldwin to the chair of biochemistry at University College in succession to Prof. F. G. Young. He combines with long and successful teaching experience the distinction of being the leading exponent in Great Britain of comparative biochemistry—the study of that vast field of strange chemical adaptations and unfamiliar solutions of the problems common to all living organisms. Such work has been Dr. Baldwin's chosen field since the time when, twenty years ago, he worked at the Marine Biological Station of Roscoff in France just after completing the Cambridge Part II Tripos courses, on the distribution of the phosphagens in the lower animals, with special reference to the prochordates. Some of his most recent work, done at Woods Hole, Massachusetts, has followed further the same story. He has also worked on the electrical organs of fishes, the phosphorus compounds in Diptera, forms of glycogen in molluscs, the general physiology of nematodes, and nitrogen metabolism in the snail. Very interesting work has recently been completed by members of his group on nitrogen excretion in *Chelonia* and in a range of aquatic and terrestrial isopods. As an author, moreover, Dr. Baldwin has achieved remarkable success. His "Introduction to Comparative Biochemistry" was well received, and later a larger "Dynamic Aspects of Biochemistry" has been widely welcomed as one of the most valuable modern books available for students of the subject. More recently, he was joint editor of the volume of addresses by the late Sir Frederick Gowland Hopkins, and of material about his life and influence, entitled "Hopkins and Biochemistry". A copy of this was received by each member of last year's International Congress of Biochemistry, not all of whom, however, can have realized the enormous amount of selfless work which Dr. Baldwin put in as joint secretary-general of the Congress, and which contributed so much to its success.

National Institute of Sciences of India: New Fellows

At a meeting of the Council of the National Institute of Sciences of India held at Poona on January 1, the following fellows were elected. *Ordinary Fellows:* Dr. D. P. Antia, development officer, Ministry of Industry and Supply, New Delhi; Dr. F. C. Auluck, reader in physics, University of Delhi; Dr. P. L. Bhatnagar, head of the Department of Mathematics, St. Stephen's College, and reader in mathematics, University of Delhi; Dr. K. Biswas, in charge of duties of director at the Herbarium, Royal Botanic Gardens, Sibpur, Calcutta; Dr. J. P. Bose, officer in charge, Department of Biochemistry and Diabetes, School of Tropical Medicine, Calcutta; Dr. R. N. Chaudhuri, professor of tropical medicine, School of Tropical Medicine, Calcutta; Dr. V. M. Ghatage, assistant professor of aeronautical engineering, Indian Institute of Science, Bangalore; Dr. H. Gupta, senior lecturer in mathematics, Government College, Hoshiarpur; Dr. T. J. Job, chief research officer, Central Inland Fisheries Research Station, Manirampur, Barrackpore; Prof. R. S. Krishnan, professor of physics, Indian Institute of Science, Bangalore; Prof. M. C. Nath, Chitnavis professor and head of the Department of Biochemistry, University of Nagpur; Dr. H. N. Ray, research officer (protozoology), Indian Veterinary Research Institute, Mukteswar-Kumaun; Dr. M. R. Sahni, superintending geologist, Geological Survey of India, Calcutta; Dr. A. Sreenivasan, lecturer in foods and drugs, Department of Chemical Technology, University of Bombay; and Dr. R. S. Vasudeva, plant pathologist, Indian Agricultural Research Institute, New Delhi. *Honorary Fellows:* Prof. P. Debye, professor of chemistry, Cornell University; Prof. M. von Laue, professor of theoretical physics, University of Berlin; Prof. M. Siegbahn, professor of physics, University of Uppsala; and Prof. E. Schrödinger, professor of physics, Institute for Advanced Studies, Dublin.

Endeavour Prizes

As a contribution to the meeting of the British Association for the Advancement of Science to be held at Birmingham in September 1950, Imperial Chemical Industries, Ltd., publishers of the quarterly scientific review *Endeavour*, have offered the sum of eighty-five guineas to be awarded as prizes for essays submitted on a scientific subject. As the primary purposes of these awards is to stimulate younger scientific workers to take an interest in the work of the British Association, and to raise the literary standard of scientific writing, the competition is restricted to those who are not more than twenty-five years of age on June 25, 1950. Three prizes will be awarded: a first prize of fifty guineas, a second prize of twenty-five guineas, and a third prize of ten guineas. The subjects for the essays are as follows: (1) Modern Techniques in Astrophysics; (2) Phenomena at Low Temperatures; (3) The Literature of Science; (4) Radioactive Tracers; (5) Metallic Corrosion; (6) Macromolecules; (7) The History and Significance of Common Salt; (8) The Scientific Method; (9) The Mechanism of Heredity; (10) The Biological Significance of Trace Elements; (11) Industrial Applications of Biology; (12) The Earth's Crust. The latest date for receipt of entries is June 26. Further information can be obtained from: The Assistant Secretary, British Association for the Advancement of Science, Burlington House, Piccadilly, London, W.1.

Supply and Demand for Chemists

The pamphlet "Present and Future Supply and Demand for Persons with Professional Qualifications in Chemistry" (London: H.M. Stationery Office. 6*d*. net) is a report prepared at the request of the Minister of Labour and National Service by a sub-committee under the chairmanship of Lord Hankey and comprising representatives of many interested bodies. Evidence was taken from various organisations, and the conclusions reached are therefore based on comprehensive information. It is stated that the universities in Great Britain are finding difficulty in recruiting academic staff of the requisite quality to attend to the needs of the greatly increased number of science graduates. Pressure on accommodation is also serious. The capacity of schools to prepare university entrants is limited. On the industrial side, it is stated that many entrants have insufficient enthusiasm for the practical applications of science, and that the needs of the process side should be kept in mind. Recruitment in physical chemistry, biochemistry and specialized analytical chemistry is found difficult, and many potential physical chemists are deterred from taking up the subject because of insufficient training in mathematics. The question of supply and demand in future was most carefully considered, and the conclusion is reached that the expanded number of chemists now undergoing training is not in excess of those likely to be required in the years ahead. The university institutions in Great Britain, which have been doing extremely well in carrying out the recommendations of the Barlow Report with temporary facilities, should have their requirements filled on a more satisfactory basis. The implications of this and other reports in the same series are discussed in the leading article on p. 125 of this issue of *Nature*.

Nuffield Foundation Fellowships

Because of the increasing size and complexity of administration, the Nuffield Foundation has been turning its attention to the need to promote the training of administrators. The Treasury has accepted an offer by the Foundation to provide £22,500 for a five-year experimental scheme of travelling fellowships for members of the Home Civil Service. The purpose of the scheme is to enable Civil servants—normally of the rank of principal or assistant secretary, or the equivalent in the professional, scientific and departmental classes—to gain first-hand acquaintance with the administration, problems, experiences and opportunities of the overseas parts of the British

Commonwealth, and possibly of Western Europe (study in the United States is already provided for by the Commonwealth Fund of America). A scheme was started by the Foundation three years ago for young farmers in Great Britain to travel abroad to study their own particular interests in farming and the wider problems of farming generally. Visits were made to Europe, America, Australia and New Zealand, and the scheme has been highly successful. It will continue until 1954, seven or eight scholarships a year being offered, each for not less than six months, and £21,400 has been set aside for the purpose. As regards the medical fellowships of the Foundation, a change of policy has taken place, and it has been decided that in future a unified medical scheme will be offered whereby a number of fellowships will be open to highly qualified and promising medical men and women who wish to train further for senior appointments in teaching or research, with preference to those specializing in child health, social medicine, industrial health, psychiatry and chronic rheumatism. £50,000 has been provisionally allotted for these fellowships, which will be worth £900–1,300 a year, for one to three years. The fellowships and scholarships in dentistry and travelling awards in extraction metallurgy will carry on as before. Altogether, during the first six years of its work, the Nuffield Foundation has spent nearly £465,000 on fellowship awards.

University Foundation, Brussels: Annual Report

The eighteenth annual report, covering the year 1947–48 (pp. 102; Bruxelles: Fondation Universitaire, 1949), of the University Foundation, Brussels, established in 1920 to assist young Belgians without means to enter higher educational institutions and to develop scientific production in Belgium, besides containing the lists of members of Council and the Publication and Grants and Library Committees and the financial statement, includes the regulations under which loans are made and some statistics for universities and high schools in Belgium. Of the 631 loans made during the year, 552 were to men and 79 to women, and 213 of these, amounting to 1,075,000 francs, went to students at the University of Brussels; other loans to students, with corresponding monetary totals, were: 80 (399,000) at Ghent, 79 (392,000) at Liège, 175 (874,000) at Louvain, 10 (115,000) at the Colonial University, Antwerp, and 21 (102,500) at the State Agronomic Institute, Gembloux. A further eighteen loans, amounting to 121,000 francs, were made to young persons for study abroad or for obtaining a supplementary diploma. Subsidies for publications during the year totalled 1,542,500 francs. Lists of institutions with which the Foundation exchanged publications during the year and to which the Foundation offered hospitality are also included, together with: a full list of recipients of grants; some notes on institutions, such as the National Foundation for Scientific Research, the Francqui Foundation and the National Cancer Foundation, with the work of which the Foundation has been associated; and notes on the exchange of professors with the United States and the arrangements for Americans to study in Belgian universities.

Grants by Private Industry to the Massachusetts Institute of Technology

The president of the Massachusetts Institute of Technology, Dr. James R. Killian, jun., has recently announced that the Institute has received industrial grants-in-aid totalling 800,000 dollars, thus bringing the total gifts to the Institute in its current development programme to 6,526,914 dollars. These new grants include 250,000 dollars from the United Fruit Co. of Boston; 50,000 dollars from an unnamed Massachusetts corporation; 250,000 dollars from the Cities Service Research and Development Co. of New York; and 250,000 dollars from the Standard Oil Co. of California. The grant of the United Fruit Co. is earmarked to be invested with endowment and other funds until the capital may be spent, upon mutual agreement between the Company and the Institute, and in the meantime the income from invested funds will be allocated each year to fields jointly selected by the two parties. These fields include such projects as the Laboratory for Biology and Food Technology and the entire range of the activities of the Institute that are unclassified from the point of view of government security. Income from the fund may be applied to fellowships, operating expenses and other appropriate types of expenditure. The Standard Oil Co. of California has specified that a substantial part of its grant be applied to chemical engineering and chemistry, nuclear science and engineering, and research projects in lubrication, friction, and wear and corrosion. The grant of the Cities Service Research and Development Co. is to be applied to research and development work in the fields of nuclear physics and chemistry, mechanical engineering (including lubrication, gas turbines and internal-combustion reciprocating engines), and chemistry and chemical engineering (including fluidization of finely powdered solids and studies of hydrocarbons). The grant is payable at the rate of 50,000 dollars a year.

Epidemic Diseases of Wildfowl

In the United States, wildfowl have been suffering from epidemic diseases, and, though there is no reason to believe that any such epidemics are likely to occur in the British Isles, investigations are being made into causes of mortality among wildfowl in Great Britain. Comparatively few wild ducks are picked up dead; but should any carcases be found it is possible that the birds may have died from some disease and that a post-mortem examination would be of value. Carcases should be forwarded to the Pathologist, Prosectorium, Zoological Society of London, Regent's Park, London, N.W.8, as quickly as possible after finding, as the longer the post-mortem examination is delayed the less likelihood there is of determining the cause of death. The birds should be carefully wrapped in paper and packed in a box in order to comply with an international post-office agreement, which stipulates that there must be no leakage from pathological specimens. The name and address of the sender, the place, and the locality and date of finding should be enclosed in the parcel. Postage will be refunded. Birds affected by oil should *not* be forwarded.

Field Scientific Liaison Work of Unesco

The Field Scientific Liaison Work of the United Nations Educational, Scientific and Cultural Organisation is described in a well-produced pamphlet recently issued by the Organisation (Pub. 361. Pp. 68; Paris: Unesco; London: H.M. Stationery Office, 1949; 1*s*. 6*d*.). Popularly but well written, it is addressed to educated people everywhere; and after a brief account of earlier international co-operation in science, including the work of the international scientific unions and the Science Co-operation Offices established during the War, it indicates how the features of both are combined in the Field Science Co-operation Offices, and then describes briefly the actual work of the four Offices so far established in Latin-America, East Asia, the Middle East and South Asia. Some account is given of the way in which these Offices have stimulated the establishment of regional research institutes and assisted in scientific reconstruction. Appendixes listing inquiries received, both as to subject and source, indicate the extent to which the four Offices are at present being used and the nature of the work, while details of the staff of the Offices and a bibliography are also appended.

Haslemere Educational Museum

THE educational value of historical and other charts arranged on a space-for-time plan has been realized since 1770 when Dr. Joseph Priestley published a synopsis of history arranged in this manner. The value of such charts in museum teaching was not recognized before 1888. In that year Sir Jonathan Hutchinson expounded, in his home museum at Inval, geology and human history by the space-for-time method. In the following year outlines of the historical and geological space-for-time schedules were given in a paper on the Haslemere Educational Museum contributed by Sir Jonathan to government educational reports. Similar outlines found a place in the Museum guide-book issued in 1912. The guide-book has long been out of print, and now an outline has been prepared, to meet the wish frequently expressed by visitors to the Museum and teachers, for a hand-guide to the space-for-time large wall schedules in the geology and history galleries. The outlines may be obtained from the Curator of the Museum, price 2*s*. 6*d*.

Sarawak Museum Journal

AFTER a gap of twelve years in publication, the *Sarauak Museum Journal* reappears in a new format, with illustrations, under the editorship of Mr. Tom Harrison, curator of the Museum. As before, the *Journal* is chiefly devoted to anthropology, ethnology and archæology, and this is indeed inevitable in such a country as Borneo, where hitherto the published information on such subjects is meagre. In the present issue is a group of papers dealing with the material aspects of Borneo culture, followed by articles on customs and beliefs, including one written in Malay. Another group deals with linguistic problems, and a smaller concluding section with zoological and botanical subjects.

The Night Sky in February

FULL moon occurs on Feb. 2d. 22h. 16m., U.T., and new moon on Feb. 16d. 22h. 53m. The following conjunctions with the moon take place: Feb. 5d. 10h., Saturn 0·4° N.; Feb. 7d. 02h., Mars 4° N.; Feb. 14d. 18h., Mercury 5° N.; Feb. 14d. 22h., Venus 13° N. In addition to these conjunctions with the moon, Mercury is in conjunction with Venus on Feb. 16d. 05h., Mercury being 8·4° S. Mercury is a morning star, rising about 1½ hours before the sun on February 1 and less than half an hour before the sun at the end of the month, but is not an easy object to observe during the twilight. Venus, which was in inferior conjunction on January 31, can be seen as a morning star from about the middle of February, rising at 5h. 40m. and 4h. 55m. at the middle and end of the month, respectively. The stellar magnitude increases rapidly during February, from −3·2 to −4·2, due to the comparatively rapid increase in the area of the visible portion of the illuminated disk after inferior conjunction. Mars rises at 22h. 06m., 21h. 18m. and 20h. 18m., at the beginning, middle and end of the month, respectively. It moves eastward away from γ Virginis until February 12 when it is stationary, and then it approaches the star to which it is very close at the end of the month. Jupiter, in conjunction with the sun on February 3, is unobservable during the month. Saturn rises early in the night and can be observed a little east of σ Leonis, to which it draws closer, so that at the end of the month the planet and the star appear close to each other. The rings of Saturn are not conspicuous at present. Occultations of stars brighter than magnitude 6 are as follows: Feb. 5d. 01h. 52·3m., χ Leon. (*R*); Feb. 5d. 22h. 25·9m., β Virg. (*R*). *R* refers to reappearance, and the latitude of Greenwich is assumed.

Announcements

SIR HENRY DALE has been elected president of the British Council in succession to Lord Riverdale, who has resigned for private reasons. Sir Henry was a member of the Executive Committee of the Council during 1943–49 and chairman of its Science Advisory Committee during 1942–49.

PROF. D. THODAY, professor of botany in the University College of North Wales, Bangor, has been appointed professor of plant physiology in the Farouk I University, Alexandria, Egypt.

PROF. W. DAVIS, emeritus professor of textiles, University College, Nottingham, has been elected an honorary life member of the Textile Institute. Prof. Davis became a member of the Institute in 1910, and served continuously as a member of its Council during 1926–49.

BRITISH CHEMICALS AND BIOLOGICALS, LTD., 43 Regent Street, Loughborough, announce that they are now in a position to supply 60 per cent hydrazine hydrate in large amounts. Besides its use in the laboratory, hydrazine hydrate finds many industrial applications, mostly as a reducing agent, but also in cases where the liberation of nitrogen gas is useful.

THE American Society for the Study of Sterility is offering an annual award of 1,000 dollars known as the Ortho Award for an essay on the result of some clinical or laboratory research pertinent to the field of sterility. The essay will appear on the programme of the forthcoming meeting of the Society to be held in San Francisco during June 24 and 25. Full particulars may be obtained from the Secretary, Dr. Walter W. Williams, 20 Magnolia Terrace, Springfield, Massachusetts; essays must be in his hands by April 1, 1950.

BEGINNING with the January 1950 issue, some changes take place in the monthly *Bibliography of Industrial Diamond Applications*, issued by the Industrial Diamond Information Bureau, 32–34 Holborn Viaduct, London, E.C.1. References to the articles abstracted are now arranged according to suggestions of the Abstracting Services Consultative Committee of the Royal Society, and their titles are printed in bold letters so that an easier survey is possible. The *Bibliography* is sent free of charge to those interested technically or commercially in industrial diamonds.

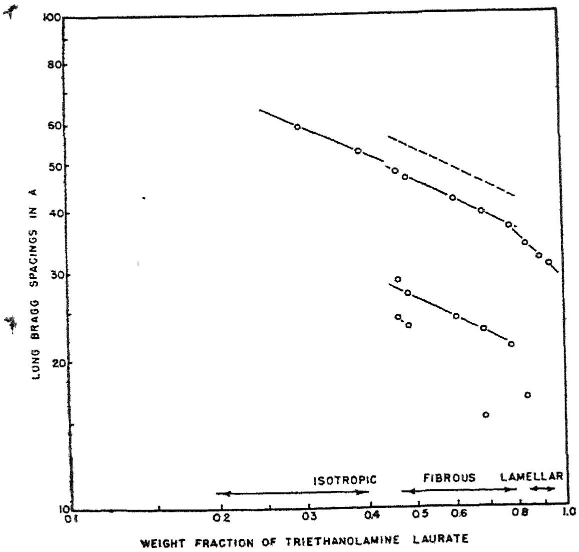
X-RAY DIFFRACTION BY AQUEOUS SYSTEMS OF TRIETHANOLAMINE LAURATE

By Dr. S. S. MARSDEN, jun., and Prof. J. W. McBAIN, F.R.S.
Stanford Research Institute, Stanford, California

A NUMBER of papers have been published, first in Germany, then in the United States, and more recently in Great Britain, on the diffraction of X-rays by isotropic solutions of soaps and other colloidal electrolytes. These results have led to theories as to the size and shape of the diffracting colloidal particles and their relation to one another. Recently a programme was undertaken in these laboratories on the study by X-ray methods of the more concentrated systems in water and other solvents. This involved the investigation of the X-ray diffraction of the liquid crystalline as well as the isotropic phases present in these systems. Ross and McBain[1] studied hexanolamine oleate in water; the present authors reported work on aqueous systems of many non-ionic detergents[2] as well as dodecyl sulphonic acid[3]; McBain and Hoffman[4] studied potassium laurate in water. A summary of some of the recent results along with a classification of the various structures deduced has recently been proposed[5].

Aqueous systems of triethanolamine laurate are interesting because they have different types of X-ray patterns for the isotropic solution, for the medium-concentration liquid-crystalline phase (middle soap), for the high-concentration liquid-crystalline phase (soap boilers neat), and for the solid soap itself. The Bragg spacings for the former three phases, as well as the concentration range in which they exist, are presented in the accompanying graph.

(1) The triethanolamine laurate was prepared by warming Eastman Kodak lauric acid (recrystallized twice from acetone) with an equivalent amount (plus 1 per cent excess) of Eastman Kodak triethanolamine (used as received) to about 50° C. The product solidified at 49·4° C. (uncorrected) after under-cooling about five degrees; it was very pale yellow—almost white—in colour. It gave an X-ray pattern somewhat similar to that of other soaps, that is, several orders of a long spacing, and a number of short spacings, most of which are of the order of 2–5 A. The Debye–Scherrer photographs are very spotty unless the sample is rotated.



(2) The high-concentration liquid-crystalline phase, which exists in the concentration range of at least 84·2–93·6 per cent soap, gives one (or two) orders of a long spacing, which change with concentration, and a side-spacing halo of maximum intensity at 4·5–4·6 A., which does not change with concentration. The numerical values of the long Bragg spacing increase with dilution. If they are plotted versus weight fraction (which is also approximately volume fraction) of soap on log–log co-ordinates, a straight line of slope -1 is approximated well within experimental error. This indicates that this phase is of the 'expanding lamellar type' of hydrous-liquid crystal[5], which consists of large bimolecular layers of surface-active molecules separated by water layers, the latter of which are all of equal thickness. On the basis of the intercept of this line with the ordinate (weight fraction equals unity) the thickness of these lamellæ is about 28·5 A. Since the calculated double length of the molecule is of the order of 36 A., the molecules in the layers must be tilted at an angle of 50–60°.

The diffraction from the long spacings (with a pinhole X-ray collimator) consists of very intense, sharp circles with pronounced intensity maxima perpendicular to the 'Pyrex' capillary in which the sample is mounted. This is also indicative of large lamellæ which tend to become oriented as they are sucked into the capillary. The side-spacing halo never shows any preferred orientation, indicating a liquid structure within the lamellæ. The second order, when observed, is always considerably weaker than the first; the reasons for this will be discussed in a forthcoming publication.

This liquid-crystalline phase may exist in a slightly larger concentration range, since the exact phase boundaries have not yet been determined. The systems in this phase are yellow-brown in colour, turbid, and birefringent; they are also very viscous.

(3) The medium-concentration liquid-crystalline phase (middle soap) exists in the concentration-range of at least 46·3–78·3 per cent soap; it may exist in a slightly greater range, since the phase boundaries at room temperature again are not exactly determined. The colloidal particles in this phase apparently consist of very long fibres or rods lying parallel and at a distance from each other. Laterally they have a hexagonal arrangement. This has been called the 'hydrous fibrous liquid crystal'[5]. A similar structure was found for aqueous systems of tobacco mosaic virus by Bernal and Fankuchen[6]. This conclusion is based on three experimental observations:

(*a*) The long Bragg spacings are in the numerical ratio of $1 : 1/\sqrt{3} : 1/\sqrt{4} : 1/\sqrt{7}$ (the latter two are not always observed, probably because of too low intensity). These correspond to the hexagonal indices $10\bar{1}0$, $11\bar{2}0$, $20\bar{2}0$, $21\bar{3}0$, respectively.

(*b*) The relative intensity of the various long Bragg spacings decreases with increasing Bragg angle. For the diffractions in the order given above they are, generally : strong (or very strong), medium (or weak), weak (or very weak), very weak, respectively. It is to be emphasized that the diffraction of the hydrous-liquid crystals, both lamellar and fibrous, is appreciably more intense and considerably sharper than that of isotropic soap solutions such as potassium laurate. The sharpness is practically that of solid soaps taken under the same experimental conditions. Thus the order or degree of arrangement in ordinary soap solutions is considerably less than that in the liquid crystals.

(*c*) These spacings increase with dilution, indicating that the fibres separate farther apart as the water is added between them. The slope of the log–log plot of long spacing versus weight fraction of soap is almost the $-1/2$ derived for an ideal system consisting of very long rods (no end corrections) separated by water. Thus the interparticle distance varies as the reciprocal of the square root of the concentration. The dashed line in the graph is the calculated distance between centres of the rods.

If these rods are *assumed* to have a square cross-section, it can be calculated that this square must be 35 A. on an edge ; this is of the order of the double length of the soap molecules. These fibres or rods may thus be pictured as a lamellar micelle of which the thickness is twice the length of the soap molecule (one bimolecular layer), width is the same or approximately the same, and length is relatively great.

The low-angle diffraction from these systems is usually very spotty unless the capillary is rotated when being photographed. Thus the oriented regions in the systems are probably of the order of 10^{-3} cm. or greater. The diffraction is not oriented, so these oriented regions in the systems also probably act as almost equidimensional particles when the capillaries are loaded. Evidently shear in these fibrous systems is not by parallel movement of the rods, whereas shear in the hydrous lamellar systems is by parallel movement of the lamellæ or groups of lamellæ.

These systems are clear, colourless and birefringent; they are also so viscous that they cannot be moved by vigorously shaking the vial in which they are prepared. When water is added to the soap during their preparation, a decided cooling occurs.

(4) The isotropic solution exists at concentrations up to 39·3 per cent and possibly slightly higher. Two systems prepared at 29·6 and 39·3 per cent soap gave diffraction of about the same intensity and sharpness as that produced by isotropic solutions of potassium laurate. A solution of 20·8 per cent triethanolamine laurate gave some centre scattering, but it was not measurable. It is evident that these isotropic solutions probably contain micelles of the same type found by other investigators for other isotropic soap and detergent solutions.

The magnitude of these long spacings is greater than those of potassium laurate, but agrees well with those found for lauryl amine hydrochloride. However, the intensity is appreciably less than that for solutions of the hydrochloride, and, of course, the diffraction is not observed for solutions of as low concentration.

Too few isotropic solutions have been studied to date to give a completely accurate picture of the structure of this phase for this soap. The slope of a line drawn through the two observed points on the graph is $-0·43$, which is appreciably greater (in absolute value) than the $-0·33$ for an ideal system made up of micelles arranged in a three-dimensional, close-packed hexagonal arrangement. However, if one *assumes* that the micelles are of a cylindrical lamellar type of height equal to diameter and with such a geometrical arrangement, it can be calculated that the height (and diameter) would be about 34 A. This is slightly less than the expected double length of the molecule, but considerably greater than the length of a single molecule.

Further work on this and other systems is in progress and will be described in detail elsewhere. This work was done under contract with the Office of Naval Research.

[1] Ross, S., and McBain, J. W., *J. Amer. Chem. Soc.*, **68**, 296 (1946).

[2] Marsden, S. S., jun., and McBain, J. W., *J. Phys. and Coll. Chem.*, **52**, 110 (1948).

[3] Marsden, S. S., jun., and McBain, J. W., *J. Amer. Chem. Soc.*, **70**, 1973 (1948); *J. Chem. Phys.*, **16**, 633 (1948).

[4] McBain, J. W., and Hoffman, O. A., *J. Phys. and Coll. Chem.*, **53**, 39 (1949).

[5] McBain, J. W., and Marsden, S. S., jun., *Acta Crys.*, **1**, 270 (1948).

[6] Bernal, J. D., and Fankuchen, I., *J. Gen. Physiol.*, **25**, 111 (1941).

A MASS-SPECTROMETER PROBE METHOD FOR THE STUDY OF GAS DISCHARGES

By R. L. F. BOYD

Department of Mathematics, University College, London

IN studying the general equilibrium of the electronegative discharge, with special reference to the collision processes occurring in an oxygen plasma, it became necessary to provide a Langmuir probe method capable of discriminating between ions of atomic or molecular species and of separating the negative ions from the electrons. Earlier workers have obtained results using the magnetic mass spectrograph as a probe[1,2]; but the bulkiness of the apparatus made it impracticable to provide a radial movement to their probe, and the difficulties of screening the discharge tube from the magnetic field made it impossible to obtain high sensitivity, because of the inevitable long path-length of the ions in the analyser and the associated vacuum and collimation problems.

In order to obtain a small instrument capable of radial movement (which is essential to a full study of the discharge) and possessing sufficient sensitivity

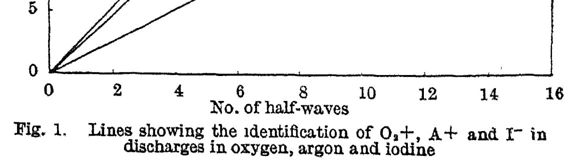


Fig. 1. Lines showing the identification of O_2+, $A+$ and I^- in discharges in oxygen, argon and iodine

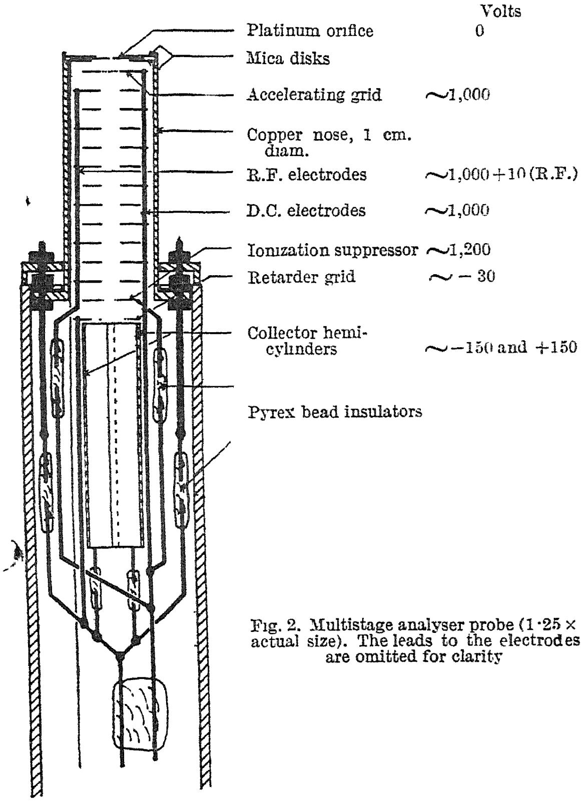


Fig. 2. Multistage analyser probe (1·25 × actual size). The leads to the electrodes are omitted for clarity

to use in weak discharges, it was decided to employ a time-of-flight method of discriminating between the mass-charge ratios of the particles.

The analysers were in the form of a linear accelerator in which the ions received a small increment of energy by passing through suitably spaced longitudinal radio-frequency fields. This enabled ions travelling at the appropriate velocity (as a result of their initial acceleration by a D.C. field) to pass a grid having a retarding potential sufficient to reject ions the velocities of which were not 'in tune' with the radio-frequency field. The instruments were built in ¾-in. diameter stainless steel tubes sliding in a copper sleeve and able to be moved radially, into and out of the 3-in. diameter discharge tube, by a wire passing through a gland in the pumping lead to the analyser.

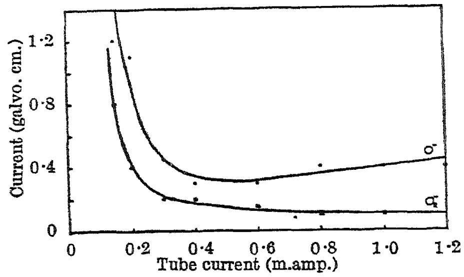
Two types of analyser have been developed and operated successfully. The first type—a single-stage model—uses a pair of radio-frequency fields localized between grid pairs and separated by a short distance. The collector-current versus frequency curve of this instrument is a series of maxima and minima depending upon the number of half-waves of the radio-frequency passing while the ion is between the two fields. A maximum occurs whenever the number of half-waves is odd. By plotting the frequencies at which current maxima and minima occur against the number of half-waves of radio-frequency passing between entry and exit of the ion, a straight line of slope characteristic of the mass–charge ratio is obtained. (The zero on the half-wave axis is obtained by extrapolation to zero frequency.) See Fig. 1.

The second type of analyser is a multistage instrument (Fig. 2) using twelve distributed radio-frequency fields in place of the two localized ones. The advantage of using distributed fields is that each ion has only one characteristic frequency, so that measurements on one ion in excess of another are more readily carried out; moreover, the radio-frequency voltage required is reduced in proportion to the number of stages, so that the problem of shielding the discharge from the radio-frequency is simpler.

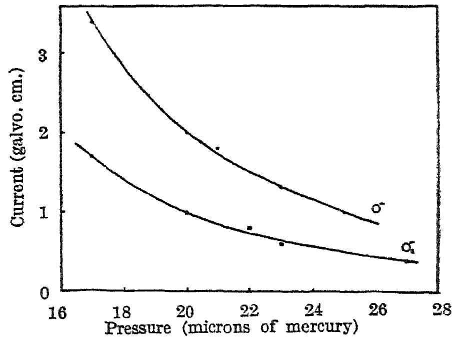
Because of the short ion path in the radio-frequency analysers, it is possible to use much larger diameters of orifice than can be used in the magnetic mass-spectrographic probes, and this, together with the absence of any need for collimating the beam, gives a sensitivity many times greater than is obtainable by magnetic analysis. Further, the disturbance of the discharge by the nose of the analyser is, because of its small diameter, very much less than has previously been possible.

These advances have made it possible to measure the radial variation in negative ion density and also to work in very weak discharges.

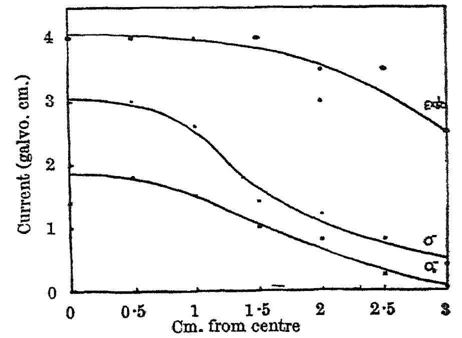
Some preliminary results showing the variation of the orifice currents of negative ions with tube



Upper curve, O^-; lower curve, O_2^-. Pressure, 0·026 mm. Hg.; probe in centre



Upper curve, O^-; lower curve O_2^-. Current, 200 μamp. probe in centre



Upper curve, $E \times 1/60$; middle curve, O^-; lower curve, O_2^-. Current, 200 μamp. pressure, 0·017 mm. Hg

Fig. 3

current, pressure and radial position in the oxygen discharge are given in Fig. 3. It will be noticed that the conventional picture of the electronegative discharge, in which the negative ions congregate in the centre, where they build up in concentration until equilibrium is established by destruction in the gas phase, tends to be confirmed; although the density of O^- at the edge of the discharge suggests that wall loss may prove to be an important contribution to the equilibrium.

A somewhat smaller multistage analyser is now being built for studying in more detail both the concentration and energy distribution of the negative ions, in certain electronegative discharges, with the view of elucidating the processes involved in the equilibrium.

[1] Spencer-Smith, J. L., *Phil. Mag.*, **19**, 1016 (1935).

[2] Lunt and Gregg, *Trans. Faraday Soc.*, **234**, 1062 (1940).

SAFE MILK IN GREAT BRITAIN

IN Great Britain neither the milk industry nor government departments concerned with it have, at least during the past two or three decades, suffered from lack of advice. On the contrary, recommendations must have showered on them from many individuals and organisations, some of whom can have had no more than a one-sided acquaintance with the farming, scientific and technological, and economic problems of this extremely complex and varied industry. Proposals made, for example, that bovine tuberculosis should be eliminated forthwith by the overnight slaughter of all reactors to the tuberculin test, or that from to-morrow no milk other than pasteurized should be consumed in Great Britain, merely indicate a lack of understanding of the dimensions of one of the most important of these problems.

Fortunately, both the industry and the government departments have developed, at least of recent years, a fairly keen sense of discrimination as between wise and constructive suggestions and those which are less good. Incautious or unrealistic government action may have serious repercussions not only on the 250,000 or so families—say, roughly a million people including dependants—whose breadwinners are engaged in milk production or distribution or in one of the several ancillary industries, but also on almost the whole of the population as milk consumers. Progress on the whole has, therefore, been a little slow, though even so some unfortunate legislative errors have been made—such, for example, as the introduction of the 'accredited' scheme without making any provision for uniformity of its administration throughout the country.

A joint Committee of the British Medical, and the National Veterinary Medical, Associations was set up by those Associations in October 1948 "to consider and report and formulate representations for transmission to government departments on the problem of providing safe milk of high quality for the community and the supervision of production and distribution of other foods of animal origin". This Committee decided at its first meeting that the most important problem to be discussed was milk, and a memorandum recently published* is an interim report which, it seems, is to be supplemented in a final report to be published later.

Even as an interim report, this memorandum puts forward recommendations which bear the stamp of careful consideration, show evidence of notable acquaintance with the industry, are, for the most part, sane and reasonable, and must clearly be taken into account by the appropriate government departments. The document is on the whole well written, does not waste words and is too full of facts to summarize in a relatively short space.

While the report was in preparation, the Milk (Special Designations) Act 1949, with the relevant Regulations regarding raw milk and also pasteurized and sterilized milk, became law. It is of interest that the Committee is in full agreement with the general intentions of the Act, but hopes that the Minister will lose no time in promoting orders by which only designated T.T. or pasteurized milk will be sold in specified areas. Few would disagree with this aspiration.

It is, however, difficult to understand why the Committee dislikes the term 'sterilized milk' and would like to see it abolished. In making this recommendation it would appear that all the facts of the case cannot have been before the Committee. There are one or two other statements in the report which would suggest that exact knowledge on a number of less well-known scientific and technical points would have helped the Committee.

In general, it may be said that in most of its recommendations the Committee is on very sound ground. Its main proposals are ahead, though not inordinately so, of existing legislation and practice in Great Britain, and point the way towards future, and it is to be hoped, not too far distant, revision and improvement.

H. D. KAY

MEDICAL USE OF RADIOACTIVE ISOTOPES

THE Ludwig Kast Lecture, which inaugurated the Graduate Fortnight for 1949 of the New York Academy of Medicine, was given by Dr. J. R. Lawrence, director of the Donner Laboratory of the University of California, who chose as the subject of his address the use of isotopes for the study and diagnosis of disease. Dr. Lawrence said that up to the present time radioactive isotopes of more than fifty elements have been used for various studies in experimental medicine, and experience has shown that no deleterious effects follow if the whole human body is given less than a tenth of a roentgen of irradiation per twenty-four hours. Usually far less than this is needed for experimental work.

Discussing iron-59 first, he explained that this has been made by bombarding cobalt-58 with deuterons. Iron is very important in the human body; but the total amount of it present is not much more than 3 gm., the iron being intimately bound up with hæmoglobin. Iron-59 emits both beta- and gamma-rays, so that it can be used not only for measuring the metabolism of iron by taking blood, urine, stools and tissues and measuring the iron directly, but also for studying its turnover and uptake in the living person, because gamma-rays can be detected when counters are placed over various parts of the body. Dr. Huff and Dr. Lawrence standardized the measurement of the rate of utilization of iron in normal human beings by injecting a radioactive tracer-dose (usually a total of 30 μgm. of iron chloride, carrying an activity of about 50 μcuries) and then taking blood samples every hour for several hours and measuring their activity, the measurements showing the rate at which iron disappeared from the plasma. By this method the fact previously known that some of the iron injected intravenously went to the red cells was confirmed. By multiplying the amount of iron cleared per unit of time by the amount going to red cells, it was possible to determine the amount of iron used in twenty-four hours by the normal human being, and to state the number of milligrams of iron incorporated in the red cells per twenty-four hours. The method thus constituted a bone-marrow function test. The results showed that an average amount of 20–25 mgm. of iron goes into the red cells. Knowing that red cells in general contain about 1 mgm. of iron per c.c. of red cells and knowing the red cell mass, it was possible to calculate the percentage of red cell iron renewed in twenty-four hours. Results showed this to be about 0·9 per cent per day, a figure which fits the known average life of the normal red cell of 120 days.

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* British Medical Association and National Veterinary Medical Association. The Provision of Safe Milk of High Quality. Pp. 8. (London: British Medical Association, 1949.)

The rate at which iron is cleared from the plasma and incorporated in the red cells in human beings suffering from various diseases was then studied. It was found that many of a group of polycythæmic patients "made iron into red cells" so fast that they were replacing as much as 5 per cent of their red cell mass per day, instead of the normal 0·9 per cent. This forced the conclusion that in people suffering from polycythæmia there is at times a rapid destruction of red cells, because the high rate of replacement of red cells could not go on indefinitely without an unlimited rise of the red cell mass or red cell count. Leukæmia is usually considered to be a disease in which the red cell production is affected by leukæmic infiltration of the bone marrow. It was found, however, that nearly all the leukæmic patients examined showed a normal or rapid rate of red cell production, so that in this disease there appears to be rapid production of both red and white cells of the blood.

It is usually considered that, in pernicious anæmia, there is arrest of red cell maturation, indicating that iron is not going into the red cells; but it was found that the iron was, in the patients with pernicious anæmia studied, going into the red cells, so that "there must be something wrong with the length of life of the red cells made". When counters were placed over various parts of the human body after intravenous administration of radioactive iron, it was possible to assess the movements of iron in the body, so that it will be possible, for example, when a patient is not making red cells normally, to predict the development of an anæmia in that patient perhaps a month or two before the anæmia actually appears.

The use of radioactive nitrogen or other radioactive inert gases, such as krypton, argon and xenon, will make it possible to measure the rate at which normal and abnormal subjects can eliminate these inert gases after saturation with them. Various age-groups show different half-times of elimination of nitrogen as determined by taking readings at various periods of time. Dr. Lawrence produced evidence that a group of young persons aged fifteen years showed a very fast half-time of elimination, the readings falling from 100 per cent to 50 per cent in a few minutes, as compared with five hours for an older age-group. He considered this to be one aspect of ageing and that we all begin ageing at an early date so far as gas exchange is concerned. Referring to the work he is doing with phosphorus-32 for labelling red cells for the determination of blood-volume, Dr. Lawrence produced evidence that when an isotonic solution of sodium radiophosphate was incubated with human blood for two hours, 40 per cent of it went into the red cells, and labelled them, so that, if these labelled red cells were injected back into the same person, the blood volume could be calculated very accurately by a dilution technique which compared the counts of the diluted phosphate-labelled red cells with the standard.

Dr. Lawrence then explained how radioactive hydrogen (^{3}H), which is now readily available, can be used for determining quickly the total body water by giving the patient a drink or an injection of radioactive water and, a quarter or half an hour later, taking a blood sample. He has applied this technique to the study of cardiac failure with œdema before and after treatment, and considers that it will be valuable for the study of various types of vascular and other diseases in which there is disturbance of water-balance. Another line of work going on in Dr. Lawrence's Laboratory is the use of such substances as hormones, vitamins, carbohydrates, proteins, fats, antibiotics, carcinogenic hydrocarbons, etc., which are built from, or labelled with, a radioactive element. Dr. Hardin Jones is, for example, using labelled organic acids and amino-acids and also glucose for the study of the metabolism of normal mice and mice carrying tumours. Another colleague, Dr. Lola Kelly, has for three years been using phosphorus-32 for the study of the metabolism of nucleic acid and has recently found that an extremely small mammary tumour in a mouse indirectly affects the metabolism of desoxypentose nucleic acid as measured by the phosphorus-32 turnover in the phosphorus-containing fraction.

Another isotope which is very extensively used is radioactive sodium. It is giving valuable information about the circulation to the extremities and about the dynamics of the flow of blood through the heart. Dr. Lawrence described a technique developed by Dr. Tobias by which extremely small amounts of gold, manganese, zinc and other elements in tissues can be measured. This technique has a sensitivity a thousand times that of any other standard method of microchemical analysis. The biological material is placed in the atomic pile for a period during which any trace element present in it can be made radioactive, usually by neutron capture. After the ash is removed from the pile, various carrier amounts of the elements of interest to the investigator are added and then extracted from the tissue, so that the radioactivity of the sample can be determined and compared with the activity induced in a monitoring sample. The Lecture concluded with a brief discussion of the work being done by Dr. Selverstone, of Boston, on the use of radioactive phosphorus for the localization of brain tumours and the somewhat similar work of Dr. Moore, of Minneapolis, with radioactive iodine incorporated into the dye di-iodofluoroscene.

Most students of the trends of medical research will agree with Dr. Lawrence's view that more and more in the future we shall think in terms of how the body handles organic and inorganic compounds, and that medicine is developing a new outlook which pays much more attention to the movements of elements, compounds and metabolites about the body.

G. Lapage

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

The Scintillation of Stars

How the heart of the astronomer would rejoice if the scintillation of stars were due, as Prof. Hartridge[1] considers possible, to physiological causes rather than to non-homogeneity of the earth's atmosphere ! It is the practice of many observing astronomers, before 'opening up', to look at the sky and note, on some estimated scale, (i) the degree of clearness or *transparency* of the sky, and (ii) the degree of steadiness or *goodness of seeing*. (i) may be judged (in the absence of strong moonlight) by the limiting magnitude of stars just visible to the eye at various altitudes, and is important, in the case of photography, for judging exposure times ; (ii) may be judged by the scintillation-frequency of the brightest stars ; the greater the frequency the worse the 'seeing' will be. On the very best nights the stars appear nearly steady, the occasional winking being slow and infrequent. Such nights are suitable for measuring close binaries, the Airy disks and their diffraction ring systems appearing steady, often for many seconds together ; on such nights, also, the finest planetary details are to be seen. When scintillation is conspicuous and rapid, the images of stars, viewed through a telescope, appear larger than the Airy disks and show a rapidly changing and uneven distribution of illumination. If the telescope is put out of focus, the star will appear as an illuminated disk showing, on a steady night, a number of fine concentric rings as in a 'zone plate'. On an unsteady night, rings are no longer visible, the whole disk appearing to 'boil'. It has been noted by British astronomers that both the scintillation and the telescopic images of stars are, in general, worse when the wind is in the east. Planets are only observed to scintillate when viewed at a low altitude on a night of exceptionally bad seeing.

'Artificial stars', made by reflecting a distant light source in a small drop of mercury, are in use at many observatories. These are not observed to scintillate unless the light path is through unevenly heated air or through air the moisture content of which is not constant, when they may be observed to do so. Such artificial stars may, however, be caused to scintillate in all but the most steady air conditions by viewing them through a telescope the objective of which is next to the eye. It will be seen that, in this case, the angular size of the source is reduced in the ratio of the 'minification' of the telescope.

In view of the foregoing it would appear that any physiological component in star scintillation would be likely to be very small, and possibly altogether absent in the case of the trained astronomer.

C. C. L. Gregory

University of London Observatory,
Mill Hill Park, London, N.W.7.
Dec. 12.

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[1] *Nature*, **164**, 999 (1949).

Hartridge and Weale[1] advance evidence for a physiological explanation of the scintillation of stars. I have made a simple observation which seems to contradict this. Sirius, seen through a misted car window, appeared as a large area of diffuse blue-white light, subtending perhaps five degrees : this light fluctuated markedly and at roughly the same frequency as the star seen through an unobscured area of the window. The effect was more readily seen when looking twenty or thirty degrees away from the star, but could be seen by direct observation.

It has been suggested to me that the diffuse area may have been made up of minute sources from each droplet which could show the 'Hartridge effect'. This seems to me invalid, for it would surely imply a statistically improbable coincidence of fluctuations from many different sources.

J. D. Morton

Officers' Mess,
Experimental Station,
Porton,
Near Salisbury, Wilts.
Dec. 16.

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[1] *Nature*, **164**, 999 (1949).

In a letter on this subject by Prof. H. Hartridge and Dr. R. Weale[1] it is stated ". . . very bright stars do not scintillate". This, however, is contrary to experience, for Sirius, for example, can be seen to scintillate in favourable meteorological conditions, as I reascertained last night.

C. J. P. Cave

Stoner Hill, Petersfield,
Hants. Dec. 16.

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[1] *Nature*, **164**, 999 (1949).

In our letter in *Nature* of December 10, we were careful to point out that the scintillation of stars may have two causes : one physical, the other physiological. In certain circumstances one or other of these may make the larger contribution.

The idea that the earth's atmosphere is in a state of turbulence appears to be very reasonable, and yet the weight of evidence seems to be against the optical effects which are ascribed to it.

(1) There should be apparent movements of the star images at right angles to the line of sight. R. W. Wood suggested that the striæ of different refractive indices had widths of about 30–40 mm. In our opinion, they definitely must be smaller than this because the scintillations of certain stars, which are clearly seen by the unaided eye, are no longer seen when a low-power telescope of 18-mm. aperture is used. If the optical effects of the striæ are to be averaged out by so small an aperture as this, the striæ themselves must have quite small dimensions. As these striæ move along in a more or less horizontal direction, they presumably refract the light from the stars and so cause the wave-fronts to vary in direction. In these circumstances we would expect the images of the stars to be in a state of tremor rather like the Brownian movement which fine particles suspended in a liquid are seen to undergo when they are examined through a microscope.

(2) It would be expected that these oscillatory movements of the star images would often be greater in one direction than in another at right angles to it, and that the direction of the larger oscillations would correspond to the direction of travel of the striæ, that is, to the prevalent direction of the wind. Thus if, as Mr. Gregory says, scintillations are usually worse in Great Britain when the wind is in the east, then the striæ are presumably travelling from east to west and therefore the oscillations should be more marked in this direction.

(3) Since at times, if not always, refraction would be accompanied by dispersion, it would be expected that the star images would be seen to consist of short spectra with definite colours to indicate which is the short wave-length and which the long wave-length end.

(4) Since they travel at right angles to the line of sight, the striæ must affect the image first to one eye and then to the other; so that the separation of these images by means of a weak glass prism would be expected to disclose a time relationship between the scintillations of the star images as seen by the two eyes. Moreover, the rotation of the head about the visual axis would be expected to disclose a position where the striæ are affecting the two eyes at the same time, and therefore are causing the scintillations seen by the two eyes closely to resemble one another.

(5) If at times the striæ are affecting separately the positions of the star images as seen by the two eyes, we would expect stereoscopic vision to cause the star to appear to undergo rapid movements in the direction of the line of sight. Thus at one moment the star should appear to dart towards the observer and at another moment to recede rapidly away from him.

We would expect that these five phenomena would follow from the theory of atmospheric turbulence: but we have never been able to see any of them, nor have we seen a description of them. What we would not expect from the theory would be alterations either of brightness or of colour, and yet these are the phenomena which are most easily observed. It is on these grounds that we find a physical explanation to be difficult of acceptance. Therefore, when Mr. Gregory writes that, before "opening up", astronomers examine the sky to see if conditions are good or bad, is it not possible that it is really physiological conditions which they are examining and not atmospheric ones? Thus when scintillations are strongly present, and excessive atmospheric turbulence is thought to be the cause, may it not be that it is the state of the eyes which is really at fault? Physiologists who carry out investigations on the detail acuity of the eye find that one day conditions are good for observation, but that the next day they are the reverse. In this case, it is most unlikely that variations in the conditions of the atmosphere are the cause of the differences between one day and the next.

Dealing now with the phenomenon mentioned by Mr. J. D. Morton, namely, the scintillations of a star, for example, Sirius, when seen through a sheet of misted glass, the fact that the whole diffusely illuminated area is seen to undergo synchronous fluctuations does at first sight appear to support a physical rather than a physiological explanation. But is this actually the case? When light sources are below the absolute threshold of stimulation of the retinal receptors, their visibility is found to be facilitated by the introduction of an additional light source. The precise cause of this phenomenon is not known. It may be due to the diffraction pattern of the new source adding its light in a strictly physical sense to the different parts of the diffraction pattern of the sources originally present; or it may be due to a process of physiological summation taking place either locally in the retina or at a distance in the brain, or possibly in some structure on the nervous pathway which connects the one with the other. Whatever the precise cause may be, there is little doubt as to the effects. Thus if we ourselves wished to see very faint stars, there can be no doubt that we should try inserting into the visual field one or more artificial stars of which the size, the intensity, and the colour could be controlled separately.

If then the light of a star is spread out, for example, by mist on glass or by being out of focus, the sudden incidence of a bright part of the image on to a local scotoma or blind part of the retina might well have the effect of plunging the rest of the image below the threshold of the surrounding receptors and thus of arresting the conscious impression.

Morton mentions another interesting point in his letter, namely, that the synchronous effect is more readily seen when looking twenty to thirty degrees away from the star but can still be seen by direct observation. It seems probable to us that both optical and retinal factors may contribute in causing the peripheral part of the retina to be better for this purpose than the centre. The optical factors are the aberrations present in the lens system of the eye for rays which make a considerable angle with the visual axis; the retinal factors are the interconnexions of the retinal receptors with one another, which are a marked feature of the peripheral retina but are practically absent from the foveal centre. In the periphery of the retina of animals it is common to find many, sometimes more than a hundred, receptors connected to one nerve fibre; whereas at the fovea each receptor has a nerve fibre of its own. Acuity and absolute threshold measurements on man strongly suggest similar arrangements.

I would like to end this letter by once more emphasizing the point that we definitely do not want to reject a physical explanation. This must, however, cover all the points which we have touched on above, and in particular must account for the changes of colour and of brightness both of celestial and of terrestrial light sources. With regard to the latter the following points may be of interest: changes of colour of nearby light sources were first described by Holmgren in 1888. He wrote, "Some observers see them easily, others with difficulty and others not at all". He gave a physiological explanation of the changes. Curiously, he did not mention variations of intensity. Many years later, changes both of colour and intensity were observed by one of us and were described without knowing of Holmgren's work. Our recent experiments have been shown to many people. We noticed that some of them see changes of brightness only, and that others see changes both of brightness and of colour.

H. HARTRIDGE

Vision Research Unit,
Medical Research Council,
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Solid Helium at 'High' Temperatures

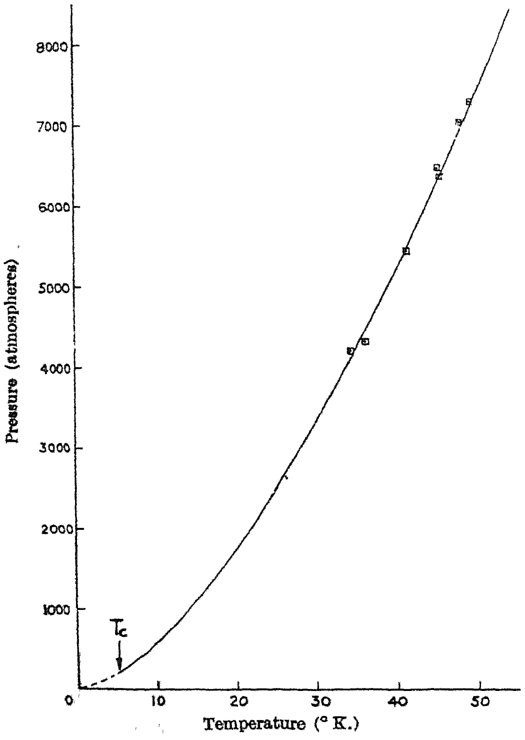
THE solid–fluid equilibrium curves (or melting curves) of ordinary substances cannot be studied over very wide temperature-ranges because of difficulties which arise from the fact that the melting pressure is always a very rapidly changing function of temperature. Thus even with the highest attainable pressures the melting temperature cannot be raised much above the ordinary liquid-gas critical temperature. However, further information in this field, particularly in relation to the question of whether a solid–fluid critical point exists, is desirable not only for its intrinsic interest but also on account of its importance in geophysics.

One of us pointed out some years ago[1] that the use of low boiling-point substances would make measurements feasible over very much larger temperature-ranges. A survey of existing data had led to the establishment of a general formula which could represent the melting curves of many substances in reduced units, the reduction factor for pressure being the internal pressure as derived from van der Waals's equation. But the substances which have low internal pressure are those with low boiling points : thus, to use helium, with its internal pressure of about 20 atm., should increase the attainable 'reduced' pressure by a factor of about 250 in comparison with substances having their normal melting points near room temperature and the internal pressures of which are of the order of 5,000 atm. This was later confirmed in experiments carried out with Ruhemann and Edwards[2], and it was shown that the melting curve of helium could be followed up to 42° K. by the application of pressures up to 5,600 atm. The equation

$$\frac{p}{16\cdot45} = \left(\frac{T}{0\cdot992}\right)^{1\cdot5544} - 1$$

(now expressed in slightly different form and converted to give pressures in atmospheres, $- 16\cdot4_5$ atm. being the internal pressure) represented the results obtained with as high an accuracy as that of the measurements themselves, except at the lower end of the curve, that is, near and below the λ-point, where, of course, helium cannot be expected to comply with any law of corresponding states.

This formula was originally deduced from experimental data obtained below 20°, and it therefore obviously lends itself well to extrapolation. If we venture to extrapolate to room temperature, the formula would suggest that, in the absence of a critical point, helium could be solidified at room temperature by applying pressures of about 100,000 atm.



We have now taken up these experiments again, with the first object of determining the form of the melting curve to still higher temperatures. High-pressure measurements on gases, particularly at low temperatures, require very special techniques. We have used the same general experimental method as in the earlier experiments mentioned above. Thus the highest pressures have been generated by 'thermal compression', starting with helium compressed to 3,000 atm. pressure at about 30° K., and solidification of the helium has been detected by the 'blocked capillary' method. Also, the helium-containing part of the apparatus has again been made in one continuous length of tubing.

The main difficulties in the old experiments arose from the hysteresis and non-linearity in the manometers employed, which reduced the accuracy of the pressure measurements at the upper end of the curve. These difficulties have been eliminated in the present experiments by making simultaneous observations *in situ* of the melting pressure of mercury at various temperatures, using the values given by Bridgman as secondary pressure standards. As a result of this and of other improvements in technique, we have now been able to make measurements at higher pressures than in the previous experiments, and with greater accuracy.

The new experimental results are shown plotted in the accompanying graph. The curve drawn is that of the formula quoted above. It will be seen that the present results are in perfect agreement with this formula within the probable limits of experimental error, believed to be not more than about ± 100 atm.

Thus we have shown that there is one substance at least which can be solidified up to temperatures as high as about ten times the liquid–gas critical temperature (T_c in the graph). The following table gives calculated values of melting pressure at 'round' temperature values :

Temperature : (° K.)	5	10	15	20	25	30	35	40	45	50
Melting pressure : (atm.)	187	580	1110	1740	2470	3280	4170	5140	6170	7270

The present experimental method is approaching its useful limit at these highest pressures, so we are publishing these results at the present time. A fuller account will be published elsewhere. New methods for the extension of measurements to still higher pressures are under consideration.

A second line of approach to the question of the existence of a solid–fluid critical point lies in the determination of entropies in the solid and the fluid states along the melting curve. This requires the measurement of the specific heats of highly compressed helium down to very low temperatures, and of the heat of melting. The variation of the entropy values with rising temperature will give an indication as to whether or not a critical point is being approached. Experiments of this kind are now in progress.

F. A. Holland
J. A. W. Huggill
G. O. Jones
F. E. Simon

Clarendon Laboratory,
Oxford.
Nov. 28.

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[1] Simon, F., *Z. Elektrochem.*, **35**, 618 (1929); *Trans. Farad. Soc.*, **33**, 65 (1937), see this paper also for references to earlier papers.

[2] Simon, F., and Ruhemann, M., and Edwards, W. A. M., *Z. physik. Chem.*, B, **2**, 340 (1929); **6**, 62 (1929); **6**, 331 (1930).

New Radioactive Isotopes Produced by Nuclear Photo-disintegration

A SEARCH has been made for new radioactive isotopes produced by (γ,n) and (γ,p) reactions in various elements irradiated with 23-MeV. X-rays from a synchrotron. Whenever possible, a chemical identification of the element responsible for the radioactivity was made. A thin-window (1·7 mgm. cm.$^{-2}$) Geiger counter was used for measuring the decay of the activities. The activities were usually too small and short-lived to permit any accurate measurement of the β-particle or positron energies.

In addition to many known radioactive isotopes, fourteen new isotopes were found. Their properties are summarized in the accompanying table.

Element irradiated	Element chemically identified	Half-life	Probable assignment
Se	As	9 min.	^{79}As
Sm	Sm	8 min.	^{143}Sm or ^{146}Sm
Eu	Eu	15 hr.	^{150}Eu
Gd	—	17 min.	^{151}Gd or ^{159}Eu
Dy	—	22 min.	^{162}Tb or ^{163}Tb
Er	—	44 min.	^{169}Ho
Yb	—	19 min.	^{171}Tm, ^{173}Tm, or ^{175}Tm
Hf	Lu	22 min.	^{178}Lu or ^{179}Lu
Hf	Lu	8 hr.	^{178}Lu or ^{179}Lu
W	Ta	48 min.	^{185}Ta
W	Ta	6 days	^{183}Ta
Os	Re	17 min.	^{189}Re or ^{191}Re
Pt	Ir	66 min.	^{195}Ir or ^{197}Ir
Hg	Au	27 min.	^{201}Au or ^{203}Au

Absorption measurements on the radiation from the 8-min. samarium showed that it is not due to α-particles.

The 44-min. activity produced in erbium has been assigned to holmium-169. The alternative assignments to erbium-163 or -165 are unlikely since no 44-min. activity has been reported in neutron-irradiated erbium. Assignment to holmium-167 is unlikely since slow neutron irradiation of holmium, in the pile, was found to produce, in addition to 27-hr. holmium-166, a new long-lived holmium isotope (half-life greater than 200 days) which is almost certainly holmium-167 produced by neutron capture in holmium-166.

Details of this work will be published elsewhere later.

I am indebted to Messrs. D. W. Fry, F. K. Goward, L. H. Metcalfe and D. J. Lees for providing facilities for synchrotron irradiations.

F. D. S. BUTEMENT
Atomic Energy Research Establishment,
Harwell, Berks. Nov. 24.

Autoradiography of Water-Soluble Tracers in Histological Sections

Two requirements for the successful preparation of high-resolution autoradiographs are the intimate contact between section and emulsion, and an emulsion-layer which is thin and of sufficiently fine grain. The stripping-emulsion technique was developed by Pelc[1] to meet these requirements, and was successfully applied to the location of iodine-131 in rat thyroid. In this technique, section and emulsion are brought into intimate contact under water. Thus it precludes the location of water-soluble tracers; moreover, the use of conventional fixing and dehydrating agents can seriously affect the concentration and distribution of water-soluble tracer in the tissue.

Scott Russell, Sanders and Bishop[2] have described a method of locating water-soluble phosphorus-32 in plant tissue. The tissue is dehydrated at $-70°$ C. in alcoholic basic lead acetate, which precipitates the phosphate *in situ*. The tissue is finally embedded in paraffin wax, sectioned and coated with stripping emulsion by the method of Pelc[1]. Holt, Cowing and Warren[3] have compared three methods of locating water-soluble phosphorus-32. Their best results were obtained by freeze-drying the tissue at $-70°$ C., followed by paraffin-wax embedding, sectioning and then clamping the sections to an Eastman Kodak nuclear track plate, a thin layer of 'Cellophane' separating the section from the plate. High resolution would not be expected under these conditions.

A method similar to that of Scott Russell, Sanders and Bishop[2] was tried by us for the location of water-soluble bromine-82 in the larvæ of *Calliphora erythrocephala*. Alcoholic silver nitrate was used for the dehydration and precipitation of the halide *in situ*; but there was evidence of damage to the tissue and to the stripping-emulsion afterwards applied.

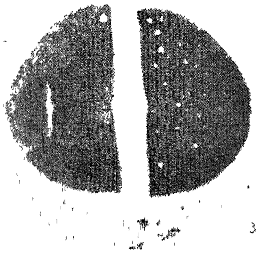
We have obtained useful autoradiographs of iodine-131 in larvæ poisoned by methyl iodide by a combination of the Altmann–Gersh process[4,5,6] and a modified stripping-emulsion technique. Methyl iodide labelled with iodine-131 was prepared on the micro-mole scale by exchange with 'carrier-free' $(I^{131})^-$ in acetone, the solvent finally being precipitated as the bisulphite compound. Larvæ were exposed for 18 hr. at 27° C. to a concentration of methyl iodide of 5 mgm./litre. The larvæ were transferred to *iso*pentane at 0° C. and cooled to $-40°$ C. Serious tissue damage sometimes occurred when the larvæ were plunged into *iso*pentane at $-180°$ C. At $-40°$ C. the larvæ were cut transversely into pieces small enough for dehydration (about 2 mm.) and then chilled by cooling the *iso*pentane to $-180°$ C. They were then placed on a platform of degassed paraffin-wax (m.p. 59° C.) in a tube maintained at $-20°$ to $-30°$ C. The tissue was then dehydrated by pumping at a pressure of less than 10^{-4} mm. mercury until the equilibrium vapour pressure at $-30°$ C. was less than 5 microns as measured on a Pirani gauge; in any event pumping was continued for not less than 48 hr. Moisture, volatile insecticide, etc., were trapped in the vacuum line at $-180°$ C. The tube and contents were then gradually warmed until the wax melted and the larvæ sank and became instantaneously embedded, high vacuum being maintained. The tube was then detached from the vacuum line, the tissue blocked out and sectioned at 10 μ or more, each section being reinforced by coating the block with molten wax (m.p. 49° C.) just before each knife traverse. The sections were mounted directly on to 3 in. × 1 in. slides (previously subbed in 1 per cent gelatin) using a trace of albumin adhesive. The wax was removed in xylol and finally rinsed in 40/60 petroleum ether. A 15-mm. square of Kodak fine-grain stripping-emulsion was then cut from the plate and drawn on to each section. The square was then gently stroked with a moist camel-hair brush, or pressed with moist filter paper, when the gelatin matrix collapsed closely over the section. Each slide on completion was dried in a vacuum desiccator for a few minutes, exposed and processed in the usual way.

Figs. 1 and 2 respectively show the concentration of iodine-131 round the partly broken wall of one of the main tracheæ and part of the cuticle in median transverse sections of a *Calliphora* larva. The mean disintegration density was estimated by a Geiger–Müller counter of known efficiency to be of the order of 10^9 d./cm.^{2} of section. Sometimes the emulsion broke away from the section in small wrinkles or

× 50

bubbles, apparently after formation of the image, because there was no loss of resolution, although section and photograph then required separate focusing under high magnification. This has happened in the case of Fig. 2. If the sections were immersed in water for a few seconds instead of being coated with emulsion, more than 90 per cent of the iodine-131 activity was lost.

When high resolution was unimportant, sections mounted as above have been clamped directly to Ilford lantern slide plates instead of being coated with emulsion. Figs. 3, 4 and 5 were obtained in this way and respectively show the distribution of bromine-82 in transverse sections of a groundnut, a wheat grain and a larva of *Calliphora erythrocephala* exposed to radioactive methyl bromide for 18 hr. The uniform distribution of bromine in the groundnut results, no doubt, from the rapid solvent action of the arachis oil, followed by protein methylation and soluble bromide formation. In the wheat grain there is little penetration beyond the aleurone layer. The main zones of concentration in the insect section correspond to the cuticle and main tracheæ. In all cases the bromine-82 activity was easily water-soluble. It is hoped to publish full details of these studies later.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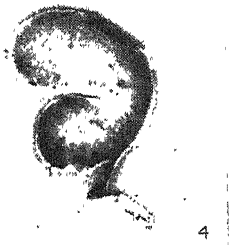
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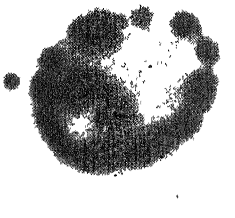
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We wish to thank Dr. R. H. Herz of the Kodak Research Laboratories for the gift of photographic material. This note is published by permission of the Department of Scientific and Industrial Research.

F. P. W. Winteringham
A. Harrison
J. H. Hammond

Pest Infestation Laboratory,
London Road, Slough, Bucks.
Oct. 24.

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[1] Pelc, S. R., *Nature*, **160**, 749 (1947).

[2] Russell, R. Scott, Sanders, F. K., and Bishop, O. N., *Nature*, **163**, 639 (1949).

[3] Holt, M. W., Cowing, R. F., and Warren, S., *Science*, **110**, 328 (1949).

[4] Altmann, R., "Die Elementarorganismen und ihre Beziehungen zu den Zellen" (Leipzig, 1890).

[5] Gersh, I., *Anat. Rec.*, **53**, 309 (1932).

[6] Hoerr, N. L., *Anat. Rec.*, **65**, 293 (1936).

Toxic Factor from 'Agenized' Proteins : Methionine as the Essential Reactant

In two recent publications[1,2] we described the isolation from nitrogen trichloride-treated zein of a crystalline substance producing convulsive fits in rabbits at a dosage of approximately 2 mgm. Owing to shortage of material, it has not yet been possible to carry out extensive feeding trials on dogs ; but in a single experiment a 10-kgm. dog given 20 mgm. of the crystalline substance developed all the symptoms of hysteria, including running and barking fits in less than 18 hours, followed by violent convulsive fits.

The analytical results so far obtained on material from several different isolations agree most closely with an empirical formula $C\ H_{12}N_2SO_3$ (found, C, 33·8, 34·2 ; H, 6·7, 6·4 ; N, 15·6, 15·4 ; S, 17·3, 17·3 ; $C\ H_{12}N_2SO_3$ requires C, 33·3 ; H, 6·7 ; N, 15·6 ; S, 17·8 per cent). Molecular weight by the method of Barger[3] gave 200. Carbon and hydrogen determinations were by combustion (Drs. Weiler and Strauss, Oxford), nitrogen determinations by the micro-Kjeldahl method. Considerable difficulty was experienced in the sulphur determination. The micro-Carius method gave consistently low results (14·9, 9·5, 9·6 per cent), confirming in this respect the findings of Callan and Toennies[4] with methionine and related compounds. The method of Olley[5], recommended for methionine, has given more consistent results, and the figures quoted represent the best of a series determined by this method. In this we were given considerable help by Miss M. Corner of the Chemical Research Laboratory, Department of Scientific and Industrial Research.

The presence of one α-aminocarboxylic acid grouping is revealed by the van Slyke ninhydrin – carbon dioxide determination at *p*H 2·5[6] (found, N, 7·8, 8·0, 7·7 ; $C\ H_{12}N_2SO_3$ requires, for one grouping, N, 7·8 per cent).

Hydrogenolysis of the crystalline substance by means of Raney nickel in aqueous solution at 100° (compare Fonken and Mozingo) gives α-amino-*n*-butyric acid obtained as colourless plates (found, N, 13·5 ; calculated for $C_4H\ NO_2$, N, 13·6 per cent), m.p. 270° (decomp.) alone and m.p. 276° mixed with an authentic specimen (m.p. 276°) derived from DL-methionine. The degradation product further gives a single spot running parallel with authentic α-amino-*n*-butyric acid on paper chromatograms in phenol, acetone, butanol and collidine.

Assuming that the toxic factor is produced by reaction between nitrogen trichloride and a known sulphur-containing amino-acid residue in the protein, the isolation of this C_4-amino-acid by hydrogenolysis clearly implicates methionine as the reactive centre, a view which is supported by the foregoing analytical results. Further, our colleague, Mr. J. G. Heathcote[8], has found that the toxic effect of the crystalline substance upon *Leuconostoc mesenteroides* P.60 can be reversed by the addition of excess methionine to the medium. Earlier work[9] from these Laboratories also implicated methionine on other grounds as the centre in the protein reacting with nitrogen trichloride to give the toxic product. In this earlier publication it was shown that proteins deficient in methionine and proteins in which methionine was destroyed by chemical action failed to exhibit the typical toxic reaction when treated with nitrogen trichloride and fed to dogs.

A molecule, $C\,H_{12}N_2SO$, can be regarded formally as being derived from methionine sulphoxide by the addition of —NH, or from methionine sulphone by the replacement of O by —NH. We have no evidence that the toxic factor is present in the crystals as a trace contaminant. However, in such a molecule there is clearly the possibility that the sulphur atom is asymmetric, with the consequence that the molecule exhibits diastereoisomerism; in such a case, the isomeric forms may differ in biological activity. With this possibility in mind we have attempted fractionation with picric acid (compare Lavine[1]). From one fraction we have obtained crystals, identical with the parent crystals when run on paper chromatograms, and giving similar analytical figures (found: C, 33 5; H, 6 7; N, 15 6; carboxyl N, 7 9 per cent) but with a different melting point, 248°. These crystals are highly toxic to rabbits. From another picrate fraction we have regenerated crystals of melting point 234°, with the same R_F values on paper chromatograms as the parent crystals, and with similar nitrogen figures (found: N, 15 4; carboxyl N, 7 4 per cent). These crystals are not toxic to rabbits within 48 hours at the 2-mgm. level. Further work is in progress.

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Reactions of Hæms with Cyanides, *Iso*cyanides and Amino-Acids

HÆM (ferrous protoporphyrin) combines with nitrogenous bases to form hæmochromogens showing, in the visible region of the spectrum, two sharp absorption bands, α 557 mμ and β 525 mμ, of which the α-band is much the stronger. It has been shown that in hæmochromogens two molecules of base are linked with each iron atom of hæm[1]. Potassium cyanide, however, differs from hæmochromogen-forming substances in giving with hæm two compounds containing one and two cyanide radicals per molecule of hæm[2,3]. Whereas the absorption spectrum of monocyan-hæm resembles that of the hæmochromogens, the absorption spectrum of dicyan-hæm differs from it, the bands being displaced towards the red end of the spectrum, and the β-band being stronger than the α-band.

Hæmochromogens in general react readily with carbon monoxide, which replaces one molecule of the base, giving rise to carboxy-hæmochromogens. During the present investigation it was found that, in the case of monocyan-hæm, carbon monoxide displaces the (CN^-) group giving carboxy-hæm, which is indistinguishable from the compound obtained when free hæm is treated with carbon monoxide. Dicyan-hæm, however, gives a CO—(CN^-)-hæm compound showing a very characteristic absorption spectrum. CO—(CN^-)-hæm shows the simultaneous co-ordination with one iron atom of two substances, each a known inhibitor of cellular respiration.

Although in a typical hæmochromogen the nitrogenous base co-ordinates with the hæm iron through a nitrogen atom, in the case of the (CN^-) group co-ordination by either the nitrogen or the carbon atom is possible. It thus appeared essential to study the reactions of hæm with non-dissociable cyanides such as methyl *iso*cyanide (methyl carbylamine, CH_3NC) and acetonitrile (CH_3CN). Methyl *iso*cyanide was found to give both a monocarbylamine-hæm and a dicarbylamine-hæm, of which only the latter has so far been described[4]. The absorption spectra of these two compounds are very similar to those of monocyan- and dicyan-hæm respectively. Moreover, dicarbylamine-hæm, like dicyan-hæm, combines with carbon monoxide, forming a CO—CH_3NC-hæm. Acetonitrile, however, does not combine with hæm, although tested under various experimental conditions. These results strongly support the view that in both monocyan- and dicyan-hæm the (CN^-) group is co-ordinated with the hæm iron through its carbon atom. It is this form of linkage which probably accounts for the great differences between the inorganic cyanide and carbylamine compounds with hæm on one hand and true hæmochromogens on the other.

When sodium hydroxide is added to a solution of protohæm in the presence of ethanol, a compound is formed with an absorption spectrum in which the β-band is much stronger than the α-band, the positions of the absorption bands being α 590 mμ, β 558 mμ and γ 435 mμ. The absorption spectrum in the visible region was first observed by Dhéré and Vegezzi[5], who described the compound as "alkaline hæmochromogen". A spectrophotometric study of this compound revealed a striking resemblance between the general pattern of its absorption spectrum and that of dicyan-hæm, which suggested that the compound might be considered as 'dihydroxyl-hæm' in which the iron atom is linked to two hydroxyl groups. This view was, in fact, borne out by further study of this compound.

Dihydroxyl-protohæm requires a high concentration of alkali (not less than *N* sodium hydroxide) and about 50 per cent v/v of a water-miscible organic solvent such as ethanol, acetone or glycol monomethyl ether, whereas the more soluble hæms such as hæmatohæm and urohæm do not require the addition of an organic solvent. When hæmatohæm in 1 per cent sodium carbonate was titrated with *N* sodium hydroxide using the double-wedge trough method[6], it was found that two hydroxyl groups are combined with the hæm iron.

Dihydroxyl-hæm is of special interest because it is formed under conditions which are favourable for the study of reactions between hæms and amino-acids.

It is well known that denatured proteins react very readily with hæms to form hæmochromogens; indeed, this reaction is a very sensitive test for denaturation occurring in the course of purification of native proteins. Yet the individual constituents of proteins, the amino-acids, with the exception of glycine[7] and histidine[8], are generally believed not to react with hæm. However, it has now been found that, under suitable experimental conditions, most amino-acids do react with hæm to form typical hæmochromogens, showing only slight differences in the positions of their absorption bands. In the course of these reactions, the absorption bands of dihydroxyl-hæm appear first and are then gradually replaced by those of the amino-acid hæmochromogen. Since urohæm is much more soluble than protohæm, it reacts more easily with amino-acids, especially with histidine, lysine, arginine and glycine, which give good hæmochromogens in 1 per cent sodium carbonate without passing through the intermediary stage of dihydroxyl-urohæm. As the reaction of urohæm with other amino-acids requires the presence of sodium hydroxide, the formation of hæmochromogen is, in these cases, preceded by that of dihydroxyl-urohæm. Of the two dicarboxylic amino-acids, only glutamic acid reacted with urohæm; but neither glutamic nor aspartic acid reacted with protohæm, although tested under a great variety of conditions. A spectrophotometric study of the reactions of protohæm with histidine, lysine and glycine showed that two molecules of each amino-acid were required per molecule of protohæm to form the corresponding hæmochromogen. The dissociation constants (K) at 20° C. were found to be $3 \cdot 4 \times 10^{-3}$ for glycine–, $1 \cdot 98 \times 10^{-3}$ for lysine– and $9 \cdot 27 \times 10^{-4}$ for histidine–hæmochromogen.

These results suggest that in the formation of hæmochromogens by denatured proteins such as globin, it is not only the imidazole groups which take part in the reaction, but also probably the free amino-groups as well. In fact, it is known that whereas a molecule of free native globin will combine with only four molecules of hæmatin or hæm to form methæmoglobin or hæmoglobin respectively, denatured globin combines with as many as twenty-four hæms to form globin hæmochromogen[7,9,10]. Since in a hæmochromogen the iron atom (Fe^{++}) of each hæm combines with two nitrogenous groups, the saturation of a globin molecule with twenty-four hæms implies the presence in the globin molecule of a minimum of forty-eight hæmochromogen-forming groups. Amino-acid analysis of horse globin has shown that the molecule contains eighty-eight basic amino-acid residues[11,12] (including thirty-six molecules of histidine) and six terminal NH_2-groups[13], which may be regarded as providing a total of ninety-four potential hæmochromogen-forming groups. Thus the molecular ratio of these groups to hæm was 94 : 24 or about 4 : 1, half of the groups reacting with hæm. On the other hand, in the case of a free amino-acid such as glycine, histidine or lysine, the molecular ratio of amino-acid to hæm must be about 1,000 : 1 for complete hæmochromogen formation. This clearly indicates that the affinity of hæm for free —NH_2-groups in a protein molecule is much greater than its affinity for these groups in individual amino-acids.

I wish to thank Dr. R. Hill for his valuable advice, and the Medical Research Council for a personal grant.

Note added in proof.—A complete account of the reactions of hæms with cyanide, *iso*cyanide and sodium hydroxide has been given elsewhere[14,15].

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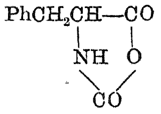
Anhydro-N-Carboxy-DL-β-Phenylalanine

In view of the increasing importance of anhydro-N-carboxyamino-acids for the synthesis of polypeptides[1,2], it is pertinent to report the following simple preparation of compounds of this type.



I

For example, DL-β-phenylalanine was heated under reflux with a solution of phosgene in toluene (10 per cent w/w) until dissolved, when anhydro-N-carboxy-DL-β-phenylalanine (I) separated in 70 per cent yield on cooling; it melted at 128–129° to a clear liquid which decomposed vigorously at about 155°. This is clearly more convenient than the procedures employed heretofore[3,4].

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Synthesis of 1:1:1 Trifluoropropyne

The simple fluorocarbon radicals $CF_3\cdot$ and $CF_3CF_2\cdot$ are obtained by the irradiation of the compounds iodotrifluoromethane and iodopentafluoroethane respectively. These radicals will initiate the polymerization of olefines, and iodotrifluoromethane with ethylene, for example, yields a polymer of general formula $CF_3\cdot[CH_2\cdot CH_2]_n\cdot I$ (where $n = 1, 2, 3$ and 4). With tetrafluoroethylene, longer chain iodofluorocarbons $CF_3\cdot[CF_2\cdot CF_2]_n\cdot I$ ($n = 1$–15) are obtained, and these in turn yield long-chain fluorocarbon radicals, $CF_3(CF_2)_nCF_2\cdot$, when heated or irradiated[1].

The reaction between iodotrifluoromethane and acetylene has now been investigated. A smooth reaction occurred under the influence of ultra-violet light or heat, and the compound 3-iodo 1 : 1 : 1-trifluoropropene, $CF_3CH{=}CHI$, was isolated. This compound formed a solid dichloride which decomposed on standing. Although 3-iodo 1 : 1 : 1-trifluoropropene was the main product from the reaction of iodotrifluoromethane with acetylene, small amounts of material with a higher boiling point were also present, and there is some evidence for the presence of the compound formed by the combination of two molecules of acetylene with one molecule of iodotrifluoromethane (that is, $CF_3CH{=}CHCH{=}CHI$). It therefore appears that the mechanism of the reaction is as follows:

$$\begin{aligned}
&CF_3I + h\nu &&\rightarrow CF_3\cdot + \cdot I\\
&CF_3\cdot + CH{\equiv}CH &&\rightarrow CF_3CH{=}CH\cdot \quad \text{(chain initiation)}\\
&CF_3CH{=}CH\cdot + CH{\equiv}CH &&\rightarrow CF_3CH{=}CHCH{=}CH\cdot, \text{ etc. (chain propagation)}\\
&CF_3CH{=}CH\cdot + CF_3I &&\rightarrow CF_3CH{=}CHI + CF_3\cdot \quad \text{(chain termination)}
\end{aligned}$$

The method of chain termination is similar to that proposed for the reaction between iodotrifluoromethane and ethylene and tetrafluoroethylene[1].

The compound 3-iodo 1 : 1 : 1-trifluoropropene has been converted into 1 : 1 : 1 trifluoropropyne, $CF_3C{\equiv}CH$, by dehydroiodination. This fluoroalkyne, which will clearly be of value in synthetic work, is a gas of boiling point c. −48°, with an odour reminiscent of that of acetylene. The presence of a triple bond was shown by the addition of two molecules of chlorine to yield $CF_3CCl_2CHCl_2$, a compound which was then further chlorinated to the compound $CF_3CCl_2CCl_3$, identical with a specimen prepared by the vapour-phase chlorination of 1 : 1 : 1 trifluoropropane. Trifluoropropyne affords a copper derivative $CF_3C{\equiv}CCu$, a silver derivative $CF_3C{\equiv}CAg$, and a mercury derivative $(CF_3C{\equiv}C)_2Hg$. The first two acetylides decompose quietly on gentle heating and violently when heated rapidly. The mercury compound is a white crystalline solid of low melting point (42–43° crude), which with iodine yields a compound, probably $CF_3C{\equiv}CI$, with an odour similar to that of diiodoacetylene.

Thus a compound which has a completely fluorinated group adjacent to a reactive triple bond is now available for synthetic work. Its chemistry is being studied and, with full details of its synthesis, will be reported elsewhere.

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A Formate-Carbonate Exchange Reaction Revealed by 'Labelled' Carbon

The preparation of formates has been examined as part of a programme for the development of reliable syntheses of isotopically labelled organic compounds.

Labelled formates have been obtained in almost quantitative yield by catalytic hydrogenation of bicarbonates[1], in 50–60 per cent yield by the acid hydrolysis of cyanide[2], and by the enzymatic reduction of carbon dioxide by *B. coli* suspensions[3]. We have obtained nearly quantitative yields of formate by the hydrolysis of aqueous solutions of potassium cyanide[4] at 150° for 4 hr., or 175° for 2 hr. The reaction is conveniently carried out in a stainless steel bomb which is shock-heated to the desired temperature in order to minimize the possibility of polymerization. All strengths of solutions up to saturation at room temperature may be used.

Commercial enriched potassium cyanide always contains potassium carbonate, often up to 25 per cent by weight. The presence of carbonate does not affect the yield of formate obtained by hydrolysis of such mixtures; but the labelled carbon is found to have become distributed between the formate and the carbonate. This is illustrated by the accompanying figures, which refer to the hydrolysis of enriched potassium cyanide in 'Pyrex' glass tubes at 250° for 2 hr.

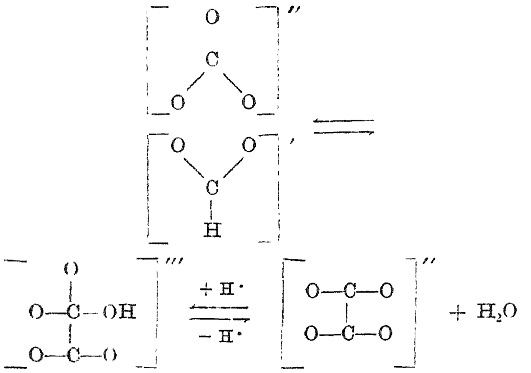
Nominal atoms % C^{13}	Potassium carbonate content (wt. %)	Atoms % C^{13}			
		CO_3'' before	CO_3'' after	CN' initial	$H.COO'$
16	12·6	1·41	8·1	16·2	15·3
56	22·7	1·76	12·2	53·4	50·8

Preliminary qualitative experiments indicate that the fundamental exchange reaction occurs between formate and carbonate. This is illustrated by the following examples. (1) A solution of 'AnalaR' sodium carbonate and pure labelled sodium formate (15·3 atoms per cent carbon-13), approximately 0·1 *M* with respect to both, was heated in a stainless steel bomb at 250° C. After 2 hr., the carbon-13 content of the carbonate had risen from 1·06 to 2·62, and after 4 hr. to 5·0 atoms per cent. (2) In another experiment a solution of approximately equal weights of carbon-14-labelled sodium carbonate and 'AnalaR' sodium formate (about 50 mgm. per ml. of each) was heated in a 'Pyrex' glass tube at 250° for 4 hr. Barium carbonate precipitated before the experiment had an activity of $4{\cdot}13 \times 10^{-10}$, and afterwards that of $2{\cdot}80 \times 10^{-10}$ curies per milligram. (3) It is also perhaps significant that when a solution of carboxyl-labelled sodium acetate (16·3 atoms per cent carbon-13 in the carboxyl group) and 'AnalaR' sodium carbonate (approximately 0·1 *M* with respect to both) was heated at 250° for 5 hr. (stainless steel bomb) there was only a very slight increase in the carbon-13 content of the carbonate (from 1·06 to 1·11 atoms per cent), probably owing to direct decarboxylation.

It was thought that under the minimum conditions for quantitative hydrolysis of potassium cyanide, the exchange reaction might be sufficiently slow as to be unimportant. A mixture of unlabelled potassium cyanide and carbon-14-labelled potassium carbonate containing 20 per cent by weight of the carbonate was therefore hydrolysed at 150° during 4 hr. However, while barium carbonate precipitated from the original solution had an activity of $3{\cdot}35 \times 10^{-10}$ c./mgm., after the hydrolysis the activity had fallen to $2{\cdot}49 \times 10^{-10}$ c./mgm. When the carbonate was precipitated by excess baryta before the hydrolysis but left in the solution, the activity at the conclusion of the experiment was $3{\cdot}02 \times 10^{-10}$ c./mgm. It is therefore necessary to precipitate and remove the carbonate before hydrolysis. After hydrolysis the solution was acidified with excess phosphoric acid and distilled at room temperature in a closed system in high vacuum. Sodium formate was isolated in 98–100 per cent overall yield by neutralization and evaporation of the distillate.

A conceivable mechanism would involve an equilibrium with the symmetrical oxalate ion.

If this is so, there would, in view of the recent work of Lindsay, McElcheran and Thode[5], be expected to



be some deviation from an equal distribution of isotope between formate and carbonate, arising from the possibility of an isotope effect in the decomposition of the oxalate ion.

An investigation into the mechanism and preparative use of the exchange, which appears to offer a unique route to labelled formate, and may have implications in other fields, is now in progress, and will be reported elsewhere.

We are indebted to Prof. R. P. Linstead for his continued help and encouragement; to Messrs. J. V. P. Long and B. N. Audric of this Laboratory for the radioactivity measurements; and to Dr. R. Bentley and his colleagues of the National Institute for Medical Research for the carbon-13 determinations. This letter is published by permission of the director of the Chemical Research Laboratory.

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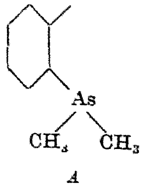
Trivalent Nickel

When investigating the complexes of bivalent nickel halides with the chelate *o*-phenylene-*bis*-dimethylarsine (A)[1], a series of very stable trivalent nickel salts have been isolated. If an alcoholic solution of nickel chloride is treated with the chelate A, a deep blood-red colour develops instantly, and by concentrating the solution a red salt $[NiA_2]Cl_2$ is obtained (found: C, 34·2; H, 4·9; Cl, 10·2; $[Ni(C_6H_4(As(CH_3)_2)_2)_2]Cl_2$ requires C, 34·3; H, 4·6; Cl, 10·1 per cent). The compound is diamagnetic with $\chi = -0{\cdot}53 \times 10^{-6}$ per gm., hence the cation is planar with the nickel using dsp^2 bonds. Attempts were made to convert this salt to the non-ionic complex $NiACl_2$ by refluxing with hydrochloric acid in alcohol solution. After some hours refluxing in the presence of air, a much less soluble, greenish-yellow substance crystallized out. In large crystals it is brown, but it dissolves in water to a small extent to a greenish-yellow solution. Its analysis agrees with the formula $NiCl_3.2A$ (found: C, 32·5; H, 4·5; Cl, 14·3; $NiCl_3.2C_6H_4(As(CH_3)_2)_2$ requires C, 32·6; H, 4·3; Cl, 14·4 per cent). The compound can also be prepared by passing chlorine into an aqueous solution of $[NiA_2]Cl_2$; the blood-red colour immediately becomes yellow and a yellow powder is precipitated almost quantitatively. An aqueous solution is slowly reduced by sulphur dioxide or stannous chloride and by boiling with hypophosphorous acid, a red solution of the bivalent salt being formed.



A

The magnetic moment supports the valency of three assigned to the nickel. The compound is paramagnetic with a susceptibility of $\chi = 1{\cdot}42 \times 10^{-6}$ per gm. (at 294° K.). After making the necessary correction for diamagnetism, the magnetic moment (μ) is 1·89 Bohr magnetons, corresponding to one unpaired electron, for which theory requires $\mu = 1{\cdot}73$. There is no decomposition after several months, the compound being stable in air, under vacuum and to moisture. When treated with potassium iodide and starch, no blue colour is developed, but the iodide is precipitated. The corresponding bromide and iodide are being investigated.

Jensen and Nygaard[2] have recently described a trivalent nickel complex, $NiBr_3.2(C_2H_5)_3P$, in which the nickel atom is five-covalent, and one might have expected the compound described above to be a salt-like analogue, since only part of the chlorine is ionized. However, conductivity measurements suggest that the substance is the octahedral complex $[NiA_2Cl_2]Cl$, and further potentiometric measurements, which are at present proceeding, seem to confirm this. The compound is remarkable for its stability and ease of formation by aerial oxidation, a reaction which is common with bivalent cobaltammines but hitherto not observed with bivalent nickel. The ease of oxidation by air is explained by the oxidation potential $[NiA_2]^{++}/[NiA_2Cl_2]^{+}$, which is estimated at $\bar{c} + 0{\cdot}8$ volt from redox titrations. A more complete discussion of these compounds will appear elsewhere in due course.

The bivalent cobalt complex undergoes similar aerial oxidation. The planar complex $[CoA_2]Cl_2$ (found: C, 33·9; H, 4·6; Cl, 10·1; $[Co(C_6H_4(As(CH_3)_2)_2)_2]Cl_2$ requires C, 34·2; H, 4·6; Cl, 10·1 per cent; paramagnetic with $\mu = 2{\cdot}1$ Bohr magnetons) is oxidized by chlorine or air and hydrochloric acid to a green paramagnetic compound which is obviously not the usual trivalent octahedral complex, since these are invariably diamagnetic. Oxidation of the salt $[CoA_2]I_2$, however, gives the almost black diamagnetic compound $CoI_3.2A$ (found: C, 23·9; H, 3·2; $CoI_3.2C_6H_4(As(CH_3)_2)_2$ requires C, 23·7; H, 3·4 per cent), which is undoubtedly the octahedral complex salt $[CoA_2I_2]I$. This work is being continued.

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An Inhibitor of Hexokinase in the Plasma of Diabetics

THE *in vitro* effects of hormones on animal hexokinase described by Colowick, Cori and Slein[1] suggested the possibility of using the hexokinase reaction as a test system for the investigation of hormonal levels in human blood. Smith[2] recently reported an unsuccessful attempt to isolate hexokinase inhibitors from fractions of diabetic plasma. In our own experiments an inhibition of hexokinase by unfractionated diabetic plasma, reversible by insulin *in vivo*, though not regularly *in vitro*, could be observed in seven out of fourteen cases investigated so far.

Four blood samples were collected from each subject in two-hourly intervals, starting at 7 a.m. The first sample was taken from the fasting subject, but the usual hospital meals were allowed thereafter (meal times : 8 a.m. and 12 noon). So far as possible each patient was examined first in absence of exogenous insulin and again in the course of insulin treatment. Sodium fluoride, in 0·3 per cent concentration, was used as anticoagulant.

A freshly prepared, centrifuged extract of rat-brain homogenate in distilled water served as hexokinase preparation. The test system contained, in a total volume of 3 ml., 1·6 mgm. of brain extract protein. Other constituents were added to give the following concentrations (M) : $NaHCO_3$, 0·02 ; $MgCl_2$, 0·0067 ; NaF, 0·0238 ; glucose, 0·00185 ; adenosine triphosphate, 0·0033. The plasma to be tested was added in amounts of 1 ml., and the solution to which it was added was modified to allow for the content of magnesium, bicarbonate, fluoride and glucose in the plasma added. Where the plasma glucose exceeded 100 mgm. per cent, the glucose content of all samples in the same experiment was adjusted to an identical level and the concentration of adenosine triphosphate was increased in the same proportion. The mixture was incubated for 30 min. at 30° C. in an atmosphere of nitrogen containing 5 per cent carbon dioxide. The reaction-rate was determined by the rate of disappearance of glucose. Differences of 17 per cent or more between the control and plasma experiments are statistically significant ($P < 0·01$).

TABLE 1. EFFECT OF DIABETIC PLASMA ON HEXOKINASE ACTIVITY. *a*, Patient deprived of exogenous insulin : *b*, patient under insulin treatment. Activity of control experiment (without plasma) = 100

Case	Sex		Time of blood collection			
			7.0 a.m.	9.0 a.m.	11.0 a.m.	1.0 p.m.
1	m	*a*	53·7	21·5	25·7	14·7
		b	40·4	72	68·5	86
2	m	*a*	105	87·5	72	53·7
		b	103	181	117	189
3	m	*a*	92	27	58	91
		b	146	66	171	82
4	f	*a*	78	64	84	31·8
		b	98	115	115	125·5
5	f	*a*	55	18·5	33	51
		b	140	128·5	219	95
6	f	*a*	93·5	89	73·5	59
		b	114	93	107	125
7	f	*a*	61	109	62·5	46·5

The results obtained with plasma of the seven diabetic cases which showed an inhibitory effect on rat-brain hexokinase are shown in Table 1. Inhibition was generally more severe (1) in untreated than in insulin-treated patients, (2) after meals than in the fasting state, and (3) in patients with high blood-sugar values and high insulin requirements than in those with milder forms of the disease. The increase of inhibition after food intake is the opposite of the tendency observed in normal subjects or in diabetics under insulin treatment, who usually received their morning injections shortly before the second blood sample was withdrawn. The inhibitory principle present in some of the diabetic plasma samples is of limited stability and loses most of its activity after storage at 0° for about twelve hours.

TABLE 2. EFFECT OF NON-DIABETIC PLASMA ON HEXOKINASE ACTIVITY. Activity of control experiment (without plasma) = 100.

Case	Sex	Time of blood collection			
		7·0 a.m.	9·0 a.m.	11·0 a.m.	1·0 p.m.
1	m	108·5	157	167	255
2	m	94·5	91·5	105	117
3	m	165	242	215	150
4	m	100	91·5	169	115
5	m	215	212	128	170
6	m	140	156	119	133
7	m	79	127	115	91
8	m	160	149	175	147
9	m	135	131	132	131
10	f	155	123	148·5	83
11	f	210	192	192	215
12	f	106·5	149	153	117

Table 2 shows the results of similar experiments performed with plasma of non-diabetic subjects. Without discussing them in detail, it may be said that significant inhibitions were not observed in this series, but that on the contrary activation effects frequently occurred. Diabetic cases which did not show the inhibition effect gave results resembling those obtained with non-diabetic plasma and, like these, sometimes caused considerable activation. The presence or absence of the inhibitory effect seems to be a permanent character, since repetition of the investigation gave similar results in the same cases.

These observations suggest the presence of activators and inhibitors of hexokinase in plasma in varying relative amounts. The variability of the effects, not only from individual to individual, but also from hour to hour, indicates a high degree of mobility and reactivity in the level of active substances, such as might be expected if they were of hormonal nature. The insulin-deficiency of the diabetic may lead to a preponderance of inhibitor hormones, and this imbalance may be corrected by insulin injection. However, addition of insulin *in vitro* has not always resulted in a complete reversal of the inhibitory action of diabetic plasma, nor did it duplicate the activation effects obtained with some samples of plasma or, in an especially striking way, of erythrocyte lysates.

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Effect of Histamine Desensitization upon Thyroxine Sensitivity

THE increased consumption of oxygen produced by thyroxine was investigated with white mice desensitized with histamine. We have published elsewhere an account of the mechanism of histamine desensitization (which is, in fact, a decreased sensitivity to histamine), and the test which was used for controlling the establishment of desensitization[1,2,3]. The oxygen consumption was recorded on an Issekutz apparatus[4] at 30° C. The experiments were performed on forty white mice, with forty controls, between the weights of 19 and 22 gm.

A dose of 1·5 mgm./kgm. thyroxine s.c. brought about an average of 54·7 per cent increase of metabolism three days after the thyroxine injection. (The average oxygen consumption of normal mice was 6·4 c.c., while after the thyroxine injection it became 9 9 c.c. during 10 min.) The same dosage of thyroxine increased the metabolism of mice desensitized with histamine on the average only by 6·3 per cent (oxygen consumption before administration of thyroxine was 6·3 c.c., after injection 6·7 c.c.). The histamine desensitization itself did not influence the metabolism.

We then investigated the effect on oxygen consumption both of a peripherally (adrenaline) and of a rather centrally (benzedrine, phenyl*iso*propylamine) acting sympathicomimetic drug on normal and on desensitized mice. Benzedrine at the rate of 4 mgm./kgm. s.c. brought about an average increase of 62·5 per cent in the metabolism of mice. This effect appeared in desensitized animals unchanged (64·2 per cent). Subcutaneous administration of 1 mgm./kgm. adrenaline to normal animals was followed with an average increase of metabolism of 73·1 per cent, which returned to the normal level in about one hour. When the mice were desensitized with histamine, the adrenaline effect was not lower, but even higher, causing an increase of 103·8 per cent in metabolism for an interval of two hours.

Thus desensitization with histamine hindered the increased metabolism produced by thyroxine, but not the effect of benzedrine and adrenaline.

These experiments were repeated with an antihistamine (pyribenzamine, N-α-pyridyl-benzyl-N-dimethylene-diamine). After the administration of thyroxine, 1 mgm./kgm. pyribenzamine was given to mice subcutaneously every second hour during 48 hr. These doses of pyribenzamine counterbalanced the effect of thyroxine (the increase of metabolism was only 12·3 per cent instead of the normal value of 54·7 per cent); however, the condition of the mice deteriorated in consequence of the continued administration of pyribenzamine.

In continuance of these experiments, we propose to investigate the detailed mechanism of this phenomenon (histamine is perhaps the stimulus-transmitting substance at the point where thyroxine attacks, that is, at the metabolism centre); further, we intend to examine the influence of a single slowly resorbed dose of antihistamine upon the thyroxine effect.

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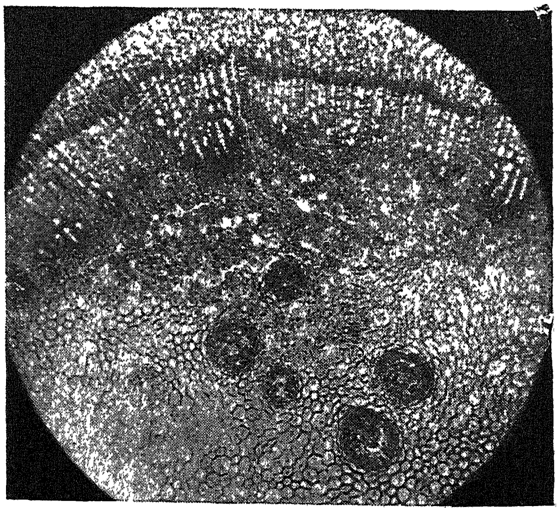
Occurrence of Medullary Bundles in the Apple Shoot

MEDULLARY bundles are known to occur in some thirty-eight families of flowering plants; but hitherto they have not been reported in the Rosaceæ. Investigations are proceeding on the apple (var. Worcester Permain on Malling II stock), from material collected in the orchards at Wye College, to try to determine not only their development and extent, but also to see whether their presence can in any way be connected with some physiological phenomenon, which will perhaps provide an indication as to their possible function. In this connexion, Alexandrov and Alexandrova[1] reported the presence of medullary bundles in the first two to three internodes of the inflorescence axis of *Ricinus communis*, appearing only after flowering and being completely absent from decapitated plants. From this they concluded that the medullary bundles were developed to meet the demands of a congested type of inflorescence. Westmaier (quoted in Haberlandt[2]) was of a similar opinion regarding their function as a result of a study of medullary bundles in the Begoniaceæ. He observed that in this family their occurrence is restricted to the stems of species that perennate by means of tubers or rhizomes, where the quantity of translocated materials passing through the stem is greater than in woody forms; and concluded that medullary bundles are formed to meet this need. Worsdell[3], in a paper on the Cucurbitaceæ, concludes that the internal phloem, which he considers a vestigial structure, being medullary bundles which have lost their xylem, is a remnant of a monocotyledonous condition. I myself regard this latter theory as improbable, owing to the occurrence of medullary bundles in families of plants which bear no systematic relation to each other.

Unlike the case in certain other families, no connexion has so far been found in apple shoots between the medullary bundles and the vascular cylinder.

Throughout their length, from the apical meristem where they are initiated, to the point where they end blindly in the pith, it is possible to follow the usual transition from procambium to mature tissues. In a transverse section of the stem a few nodes from the apex, the bundles are seen to consist of a central phloem surrounded by radially arranged rows of cells which will ultimately become lignified and which probably originated from a cambium.

Regarding their longitudinal extent, it would appear that their formation is not continuous throughout the growing season, so that one finds isolated groups of bundles at intervals throughout the length of the stem, which are separated from those above and below by normal pith. Up to the present, their



A transverse section through the second internode of a one-year old apple shoot showing five clear medullary bundles in the pith course has been found to extend throughout the first- and second-year wood.

With the idea of seeing if there was any difference in the occurrence of medullary bundles in trees growing on different stocks, I collected shoots growing on Malling XVI and Malling IX rootstocks. No medullary bundles have as yet been found in the variety Worcester Permain growing on Malling XVI, which is a vigorous stock, but only on the dwarfing Malling IX stock.

My thanks are due to Dr. B. A. Beakbane, of East Malling Research Station, for facilitating the collection of material from the orchards there.

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Endosperm in *Cassia tora* Linn.

During the course of a comparative study of several members of the Leguminosæ, I found an interesting type of endosperm formation in *Cassia tora* Linn. (family Cæsalpiniaceæ), a common roadside plant in India. The primary endosperm nucleus, by repeated division, gives rise to a number of free nuclei which are at first more or less uniformly distributed throughout the embryo-sac. Afterwards, one of the nuclei situated near the chalazal end becomes more prominent than the rest of the endosperm. Wall formation takes place only in the micropylar part of the endosperm. The chalazal part, which remains free nuclear, becomes a narrow tube with denser cytoplasm in its elongated lower end (Figs. 1 and 2). As the mass of endosperm tissue increases, the lower tubular process becomes irregularly coiled and twisted. The sac-like portion at its tip is often displaced so that it is sometimes found lying on one side of the cellular zone or superposed on it (Fig. 3). Microtome sections naturally fail to give any clear or complete picture of this interesting tubular process; but whole mounts of the endosperm showed it quite clearly.

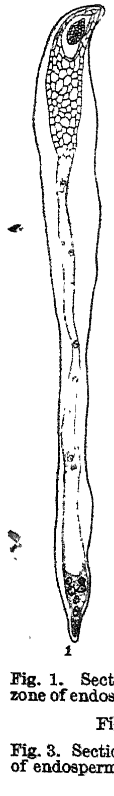

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Fig. 1. Section of the embryo sac showing the embryo, cellular zone of endosperm and lower tubular portion of endosperm. × 110

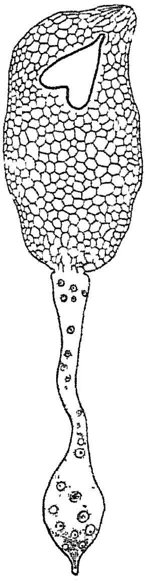

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Fig. 2. Whole mount of endosperm. × 55

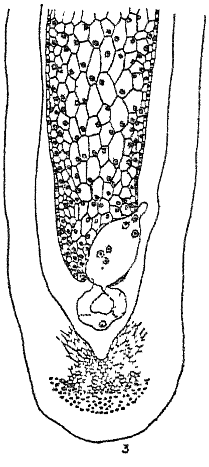

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Fig. 3. Section of chalazal half of seed showing coiled tubular part of endosperm lying superposed on the upper cellular part. × 55

A similar condition has been observed to exist in some other species of *Cassia*, and a detailed account of their embryology will be published elsewhere. To the best of my knowledge, this feature is unknown in the Leguminosæ and is probably rare in other angiosperms also.

I am grateful to Prof. P. Maheshwari of the University of Delhi for his valuable suggestions.

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Non-Mendelian Segregation from Heterozygotic Yeast Asci

If M denotes a gene for the production of maltase and m its allelomorph, which is unable to produce the enzyme, a heterozygotic 4-spored yeast ascus originally having the formula Mm would be expected to yield a simple Mendelian segregation ratio of 2 : 2; that is, two of the spores should give rise to maltose-fermenting types, while the other two spores should give rise to non-fermenting types.

During an investigation of the inheritance of the ability of yeasts to ferment maltose, the presence of three polymeric M-genes, M_1, M_2 and M_3, in *Saccharomyces cerevisiæ* was established[1].

In subsequent studies, an M_1M_1 m_2m_2 m_3m_3 type was obtained, and this was backcrossed to a non-fermenting type, m_1m_1 m_2m_2 m_3m_3. The hybrid thus formed consequently should be the single heterozygote M_1m_1, and its progeny would be expected to yield a simple 2 : 2 segregation. Two such hybrids, Nos. 65 and 66, were produced by spore crossings and the segregation ratios of their progeny investigated.

Twelve 4-spored asci from hybrid 65 were analysed and all were found to give 2 : 2 ratios. Hybrid 66 gave, however, in addition to 12 normal 2 : 2 segregating asci, one ascus with three maltose fermenters and one non-fermenter. How could this behaviour be explained without resorting to Winkler's so-called "conversion theory"[2] (which Lindegren also supports in his investigations on yeast genetics[3]), namely, that in a heterozygotic yeast a gene may be contaminated by its allelomorph and thereby may be transformed into the latter ? We consider this theory to be highly improbable. It occurred to us, however, that an obvious explanation could be that the four nuclei of the divergent 3 : 1 segregating ascus had each undergone an additional mitosis, resulting in the formation of four M nuclei and four m nuclei, but that four of these had afterwards degenerated so that at sporulation only four uninucleate spores had been produced. The segregation ratio in such a case would be entirely a matter of chance. A search was therefore made for asci containing more than four spores, and we were successful in finding

5-spored asci in both hybrids, as well as a 6-spored ascus in hybrid 66.

All the spores from a 5-spored ascus of hybrid 65 were isolated, but only four of them germinated. These four gave a segregation ratio of $3M : 1m$.

A $3M : 1m$ segregation was also obtained from a 5-spored ascus of hybrid 66, in which only four spores germinated.

All ten spores from two 5-spored asci of hybrid 66 germinated, and both asci segregated out as $2M : 3m$.

Finally, all the spores from a 6-spored ascus of hybrid 66 were isolated, but only four of them germinated and gave a ratio of $3M : 1m$.

It is thus evident that 8-nucleate asci are produced in this material. When asci of this type produce only four spores, the chances, according to a simple calculation of probabilities, will be that :

51·4 per cent asci will segregate as $2M : 2m$
22·9 ,, ,, ,, ,, ,, ,, $3M : 1m$
22·9 ,, ,, ,, ,, ,, ,, $1M : 3m$
1·4 ,, ,, ,, ,, ,, ,, $4M : 0m$
1·4 ,, ,, ,, ,, ,, ,, $0M : 4m$

If, for example, 10 per cent of the 4-spored asci had originally contained eight nuclei, it would thus be expected that *c.* 4·6 per cent of them would yield either 3 : 1 or 1 : 3 segregations instead of the normal 2 : 2 ratio.

This proof of the occurrence of additional nuclear divisions within the ascus gives, therefore, a simple explanation for the fact that exceptions to classical Mendelian ratios may occur.

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Carbohydrase Specificity in *Saccharomyces* Hybrids

THE substrate specificity of the yeast carbohydrases has been studied by many authors[1-3]. It has been concluded[4,5] that standard industrial yeasts—brewers', distillers' and bakers' yeasts—contain carbohydrases the substrate specificity of which is determined qualitatively only by the nature of the glucosidic terminal unit of the sugar substrate. On this basis, distinction has been made between the following: (1) a beta-fructofuranosidase which catalyses the removal by hydrolysis of the fructofuranosidic terminal from sucrose, raffinose, stachyose, gentianose and beta-methylfructofuranoside, (2) an alpha-glucosidase which catalyses the removal by hydrolysis of the alpha-glucosidic terminal from maltose, sucrose, turanose, melezitose and suitable synthetic alpha-alkyl glucosides and alpha-aryl glucosides, and (3) an alpha-galactosidase, which catalyses the hydrolyses of the alpha-galactosidic terminal from melibiose, raffinose and alpha-phenyl galactoside.

Enzyme preparations derived by us from haploid hybrid *Saccharomyces* strains of genetically defined constitution[6] do not conform with this classification. These yeasts yield an alpha-glucosidase which acts rapidly on alpha-methyl glucoside and is inert both to maltose and some other oligosaccharides with a terminal alpha-glucosidic unit. The haploids have also provided a specific sucrase which acts neither on raffinose nor maltose. It is therefore to be concluded that the number of the yeast carbohydrases is larger and their substrate specificity much narrower than has hitherto been supposed. The differentiation in the yeast material of a specific alpha-methyl glucosidase and a new sucrase provide an apt illustration of the effectiveness of the genetic method.

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Occurrence of Unusual Positive Coombs Reactions and *M* Factors in the Blood of a Mother and Her First Baby

FOLLOWING routine investigations of blood factors of a woman, aged twenty-four, and her first baby, it was found that the red cells of the mother and her child both gave positive reactions to the Coombs test, when first tested shortly after the birth of the child, and on several occasions during the next eighteen months. The red cells of the father, and those of a second child born fifteen months after the first, gave negative reactions to the Coombs test.

The mother's blood was A_1, *Rh*-positive (R_1R_1), *P*-negative, and when first tested appeared to be type *N*. The first baby was A_1, *Rh*-positive (R_1R_1), *P*-negative and type *M*. The father was A_1, *Rh*-positive (R_1R_1) and type *M*. The second baby's blood was A_1, *Rh*-positive (R_1R_1) *MN*, and did not give a positive Coombs test. (The anti-*Rh* sera used were anti-*rh′* (anti-*C*), anti-Rh_0 (anti-*D*), anti-*rh″* (anti-*E*), and anti-*hr′* (anti-*c*). It is therefore probable, and has been assumed, that the genotype in each case was R_1R_1 rather than the very rare R_1R'.) The mother's serum did not agglutinate cells containing agglutinogens R_1, R_2, r, M, N, P or p, Lewis-positive or Lewis-negative cells. Kahn reactions were negative in blood of mother and first child.

There was no clinical or laboratory evidence, except the positive Coombs reactions, to suggest hæmolytic disease, either in the mother or the first baby, nor could species reaction to normal rabbit serum be demonstrated. It is therefore suggested that the positive Coombs tests were due to the presence of abnormal receptors of a hereditary nature, and that an unidentified antigen in the pooled human serum used to immunize the rabbits for the production of Coombs reagent had stimulated antibodies reactive with these receptors.

The *M*- and *N*-types of the mother and first child, when first tested with single samples of potent *M*- and *N*-testing fluids, appeared not to conform with the accepted rule of heredity of these factors, and special tests for the detection of a possible N_2 factor were negative. Samples of the blood of the mother and the first child were then sent to Dr. R. R. Race. He found that the mother's red cells were agglutinated by one of two samples of anti-*M* serum of human origin. We later tested the mother's red cells with seven further samples of anti-*M* serum, five produced by immunization of rabbits and two of human origin; one of the rabbit sera and both human sera caused no agglutination, whereas the other four rabbit sera caused strong agglutination. It appears that the mother's red cells contain a variant of the *M*-factor, which was detected only by five out of ten samples of the anti-*M* sera, all of which gave strong agglutination with known controls and many other samples of cells.

A full report of this case is to be published in the *Medical Journal of Australia*.

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Non-Coaxiality of Principal Normal Stresses and the 'Strain' Ellipsoid in the Classical Theory on Infinitesimal Deformation

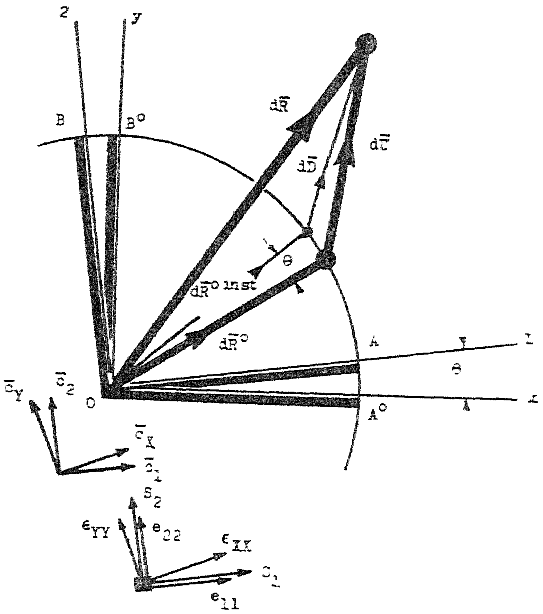
A fundamental assumption in the classical theory on infinitesimal deformation in isotropic substances is that such an equation as (6) reduces to principal normal 'strains' ε_{11}, ε_{22} only when the co-ordinate axes are in the principal normal stress directions[1,2]. This *hypothesis* is shown in this communication to be untrue, in general, since this 'strain' ellipse is defined by means of gradients of 'spatial-displacement' $\mathbf{U}$. Because the reference axes as used in the classical theory are fixed in space and independent of the deformed body, $\mathbf{U}$ contains a component due to 'rotation-of-the-body-as-a-whole'[3] even when this rotation is only infinitesimal. Thus, while all workers agree on the meaning of *physical* principal normal strain and stress directions, and that they are co-axial in an isotropic substance, the use of 'spatial-displacement' gradients to define strain leads to *mathematical* non-coaxiality with stress.

For brevity in writing, consider only two-dimensional displacement effects induced by a plane principal normal stress system S_1, S_2. Cartesian reference axes Ox, Oy are spatially fixed and have their *origin* at an arbitrary point of the deformed body. With respect to these fixed axes an adjacent point at initial position $d\mathbf{R}^0$ suffers a differential relative 'spatial-displacement' $d\mathbf{U}$. The gradients of the displacements will be restricted to infinitesimal values.

Then geometrically,

$$d\mathbf{R} - d\mathbf{U} = d\mathbf{R}^0. \tag{1}$$

Suppose the substance is isotropic and elastic so that orthogonal line elements of the *deformed* body in directions $\mathbf{c}_1$, $\mathbf{c}_2$ will have suffered stretch only and would merely contract and still be orthogonal if stresses S_1, S_2 were removed from the *element*. OA, OB are such contracted elements; but in general they would be initially OA^0, OB^0 in the figure, where angle θ of rotation is infinitesimal. Thus if the *element* were unloaded, the adjacent point at $d\mathbf{R}$ would contract to $d\mathbf{R}^{0\,\mathrm{inst}}$ corresponding to $d\mathbf{R}^0$ rotated through angle θ. Thus with $\mathbf{D}$ as 'straining-displacement'[3] gives geometrically,



$$d\mathbf{R} - d\mathbf{D} = d\mathbf{R}^{0\,\mathrm{inst}} = d\mathbf{R}^0 + \theta d\mathbf{R}^0.(\mathbf{c}_2\mathbf{c}_1 - \mathbf{c}_1\mathbf{c}_2) \tag{2}$$

and

$$d\mathbf{U} = d\mathbf{D} + \theta d\mathbf{R}^0.(\mathbf{c}_2\mathbf{c}_1 - \mathbf{c}_1\mathbf{c}_2). \tag{3}$$

(In a three-dimensional analysis, it is convenient to use a 'versor operator' $\mathscr{Q}$ to 'rotate' vector $\mathbf{R}^0$ to position $\mathbf{R}^{0\,\mathrm{inst}}$ through angle θ about an axis in the direction of the unit vector $\mathbf{a}$. Thus with idemfactor $\mathscr{I}$,

$$\mathbf{R}^{0\,\mathrm{inst}} = \mathscr{Q}\,.\,\mathbf{R}^0$$
$$\mathscr{Q} = \mathbf{aa} + (\mathscr{I} - \mathbf{aa})\cos\theta + \mathbf{a} \times \mathscr{I}\sin\theta.$$

Gibbs, in "Vector Analysis" (1901), derives this operator algebraically, arguing along 'quaternionic' lines, whereas I recently derived it independently using geometrical reasoning with the usual scalar and vector product definitions without being aware of Gibbs's treatment. This operator has proved most useful in a treatise now in preparation.) However, body continuity requires $\mathbf{U}$ and $\mathbf{D}$ as continuous point functions so that the scalar coefficients of $\mathbf{c}_1$, $\mathbf{c}_2$ respectively in (3) expanded are,

$$\begin{aligned} U_{1,1}dR_1 + U_{1,2}dR_2 &= D_{1,1}dR_1 + \theta dR_2^0 \\ U_{2,2}dR_2 + U_{2,1}dR_1 &= D_{2,2}dR_2 - \theta dR_1^0 \end{aligned} \tag{4}$$

with $U_{1,1} \equiv \partial U_1/\partial R_1, \ldots$, for brevity.

Neglecting squares and products of displacement gradients such as $U_{1,1}, \ldots$, then the squaring of (1) by scalar multiplication gives,

$$d\mathbf{R}\,.\begin{bmatrix}(1 - 2U_{1,1})\mathbf{c}_1\mathbf{c}_1 + (1 - 2U_{2,2})\mathbf{c}_2\mathbf{c}_2 \\ - (U_{1,2} + U_{2,1})(\mathbf{c}_1\mathbf{c}_2 + \mathbf{c}_2\mathbf{c}_1)\end{bmatrix}.\,d\mathbf{R} = (dR^0)^2. \tag{5}$$

With ε_{11}, ε_{22}, ε_{12} for 'strains' and r_1, r_2 for direction cosines of $d\mathbf{R}$ with respect to $\mathbf{c}_1, \mathbf{c}_2$ gives the usual expression[1,2],

$$\left(\frac{dR^0}{dR}\right)^2 = 1 - 2U_{1,1}r_1^2 - 2U_{2,2}r_2^2 - 2(U_{1,2} + U_{2,1})r_1r_2$$
$$= 1 - 2\varepsilon_{11}r_1^2 - 2\varepsilon_{22}r_2^2 - 2\varepsilon_{12}r_1r_2. \qquad (6)$$

Since the dyadic in (5) is self-conjugate, then 'principal' directions $\mathbf{c}_X$, $\mathbf{c}_Y$, say, can be found[4] to give,

$$d\mathbf{R} \,.\, [\,(1 - 2U_{X,X})\mathbf{c}_X\mathbf{c}_X + (1 - 2U_{Y,Y})\mathbf{c}_Y\mathbf{c}_Y]\,.\, d\mathbf{R} = (dR^0)^2. \qquad (7)$$

This is an ellipse, since both the coefficients are positive; but its axes are not in the directions $\mathbf{c}_1$, $\mathbf{c}_2$ of the principal normal stresses S_1, S_2. However, if θ the angle of rigid rotation of the element of substance is zero in (4), then $U_{1,1}$ and $U_{2,2}$ equal $D_{1,1}$ and $D_{2,2}$ respectively, and (5) becomes,

$$d\mathbf{R} \,.\, [\,(1 - 2D_{1,1})\mathbf{c}_1\mathbf{c}_1 + (1 - 2D_{2,2})\mathbf{c}_2\mathbf{c}_2]\,.\, d\mathbf{R} = (dR^0)^2. \qquad (8)$$

This is precisely the ellipse that would follow from (2) considering 'straining-displacement', since $(dR^{0\ \text{inst}})^2$ equals $(dR^0)^2$, and its principal axes are in the directions of the principal normal stresses as required.

Thus it is seen that allowing just an infinitesimal 'rotation of the body as a whole' (in my sense[3]) through angle θ leads to the loss of one–one correspondence between principal normal stresses and 'strains' defined by 'spatial-displacement' gradients.

The argument is developed similarly in the three-dimensional case. If the rotation of the body *as a whole* is finite, then clearly the effects noted here will be accentuated. A recent note[5] pointed out that the classical finite 'strains' expressions non-linear in displacement gradients are unnecessary even when 'straining-displacement' is used in their definition. If in the definition of those non-linear expressions 'spatial-displacement' be used, as is done by others than myself, then apart from their other disadvantages, such strain expressions cannot have one–one correspondence with stress, as has been shown in the present communication.

K. H. SWAINGER

Imperial College of Science and Technology,
London, S.W.7.
July 30.

[1] Love, A. E. H., "Mathematical Theory of Elasticity" (Camb. Univ. Press, 1934).

[2] Sokolnikoff, I. S., and Specht, R. D., "Mathematical Theory of Elasticity", 66, 67 (McGraw-Hill, 1946).

[3] Swainger, K. H., *Phil. Mag.*, **38**, 422 (1947).

[4] Weatherburn, C. E., "Advanced Vector Analysis" (Bell, 1937).

[5] Swainger, K. H., *Nature*, **163**, 23 (1949).

Combustion of Liquid Fuels

A RECENT letter by Godsave[1] described experiments on the combustion-rates of single liquid-fuel droplets. The general case of the combustion of liquid fuel in gas streams is being studied at this Laboratory, and it may be interesting to outline the approach made and the preliminary results, which will be published elsewhere[2].

Heat transfer between a body and a fluid flowing past it is often pictured as occurring by thermal conduction across a stagnant film of fluid adhering to the body, while the temperature throughout the bulk of the liquid is supposed substantially constant; an analogous simplification is commonly made when matter transfer takes place in like circumstances. By assuming the thickness of the film to depend only on the nature of the fluid and the pattern of flow past the body, it is possible to predict heat-transfer coefficients from matter-transfer experiments, and vice versa.

In the present theory of liquid-fuel burning, the combustion is supposed to occur within a similar stagnant film surrounding the liquid mass. The film is divided into two parts by a surface, parallel to the film boundaries, at which the chemical reaction occurs. Fuel vapour and oxygen diffuse towards this surface from the inner and outer boundaries respectively, and combustion products diffuse outwards. A small proportion of the heat of reaction is conducted inwards to provide the latent heat of vaporization of the fuel and the enthalpy increase of its vapour, while the remainder is conducted outwards towards the gas stream. For a given fuel and atmosphere, the temperature and matter distributions can be calculated from the ordinary laws of thermal conduction and molecular diffusion; these distributions are independent of the film thickness. In particular, the temperature at the reaction surface can be found; it is different in general from the adiabatic flame temperature.

The combustion-rate can then be calculated if the thickness of the effective stagnant film is known. This thickness has been determined implicitly by many investigators in heat- and matter-transfer experiments on various systems, for example, spheres in gas streams.

It is convenient in practice to imagine the burning fuel surface to be replaced by a solid surface at such a temperature that the rate of heat addition to the gas stream is unchanged. The required temperature is calculable from the properties of the fuel and the gas, and is independent of the thickness of the stagnant film, that is, of the shape of the body and the velocity of the gas stream. Thus a kerosene surface burning in air at room temperature adds heat to the atmosphere at the same rate as would an identical solid surface at a temperature of 25,000° C. above its surroundings.

The theory has been confirmed experimentally by measuring the rate of burning of kerosene by natural convection from a spherical surface of 1½ in. diameter, the effect of latent heat variations being simulated by cooling the sphere internally. The measured rates were about 50 per cent of the theoretical, and lay on similar curves. It was found that the combustion-rate increases as heat of combustion and atmospheric temperature and oxygen concentration increase, and as latent heat of vaporization decreases. The 'volatility' of the fuel is irrelevant, when the steady state has been reached. The extinction limits of the flame and the occurrence of smoke appeared to depend on the peak temperature within the film, as did also the reaction mechanism.

Further study is being directed to combustion by forced convection.

D. B. SPALDING

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Nov. 14.

[1] *Nature*, **161**, 708 (1949).

[2] *Fuel*, **29**, Nos. 1 and 2 (1949).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, January 30

Chemical Society, Leeds Section (in the Chemistry Lecture Theatre, The University, Leeds), at 6.30 p.m.—Dr. F. L. Rose: "The Basis of Chemotherapeutic Research".

Tuesday, January 31

Royal Anthropological Institute (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Prof. Alexander Galloway: "The Border Cave Skull in relation to the Middle Stone Age Skulls of South Africa".

Institution of Electrical Engineers, Measurements Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Metering of Welding Loads" (to be opened by Mr. G. F. Shotter).

Manchester Geographical Society (at the Geographical Hall, 16 St. Mary's Parsonage, Manchester), at 6.30 p.m.—Mr. C. Owen Hockin: "Some Hebridean Islands".

Royal Aeronautical Society (at 4 Hamilton Place, London, W.1), at 7 p.m.—Mr. J. H. Argyris: "Further Problems of Aircraft Stressing".

Sheffield Metallurgical Association (at 198 West Street, Sheffield), at 7 p.m.—Prof. H. O'Neill: "The Atomic Structure and the Hardness of Metals".

Royal Meteorological Society, Midland Centre (at the University, Birmingham), at 7.15 p.m.—Mr. J. K. Bannon: "Thunderstorms".

Pharmaceutical Society, Manchester, Salford and District Branch (in the Council Chamber, Houldsworth Hall, Manchester), at 7.45 p.m.—Mr. B. J. Thomas: "Modern Development in Pharmaceutics".

Wednesday, February 1

Royal Society of Medicine, History Section (at 1 Wimpole Street, London, W.1), at 4.30 p.m.—Dr. F. F. Cartwright: "Humphry Davy's Contribution to Anæsthesia".

Geological Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

British Institution of Radio Engineers, Merseyside Section (at the Accountants' Hall, Derby Square, Liverpool), at 7 p.m.—Mr. D. R. Hardy: "The Measurement of Small Currents".

Institution of Electrical Engineers, London Students' Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 7 p.m.—Mr. T. E. Schilizzi: "Blind Landing".

Society of Public Analysts and other Analytical Chemists, Physical Methods Group (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 7 p.m.—Discussion on "Modern Methods of Moisture Determination".

Thursday, February 2

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

Chemical Society, St. Andrews and Dundee Section (under the auspices of the British Association Dundee Trust, in the Chemistry Department, University College, Dundee), at 5 p.m.—Sir Edmund Whittaker, F.R.S.: "The Concept of Nature, from Copernicus to Newton". (All Fellows are invited.)

Chemical Society, North Wales Section (joint meeting with University College Chemical Society, in the Department of Chemistry, University College, Bangor), at 5.30 p.m.—Prof. F. E. King: "Some Aspects of the Chemistry of Simple Peptides".

Chemical Society, Sheffield Section (joint meeting with the University Chemical Society, in the Chemistry Lecture Theatre, The University, Sheffield), at 5.30 p.m.—Prof. H. W. Melville, F.R.S.: "The Breakdown of High-Polymer Substances".

Institution of Electrical Engineers (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. W. Casson and Mr. F. H. Birch: "Fault-Throwing Tests on the 132-kV. Grid System under Normal Working Conditions".

Royal Statistical Society, London Group of the Industrial Applications Section (joint meeting with the Institution of Engineering Inspection, at the Royal Society of Arts, John Street, Adelphi, London, W.C.2), at 6 p.m.—Dr. B. P. Dudding: "A Survey of Present Methods of Industrial Statistics".

British Institution of Radio Engineers, Scottish Section (at the Institution of Engineers and Shipbuilders, Glasgow), at 6.45 p.m.—Mr. A. J. Tyrrell: "The Performance and Stability of Permanent Magnets".

Chemical Society (at Burlington House, Piccadilly, London, W.1), at 7.15 p.m.—Scientific Papers.

University of London (at Wye College, Wye, near Ashford, Kent), at 8.15 p.m.—Sir William Ogg: "Some Aspects of the Work at Rothamsted".*

Friday, February 3

Institution of Chemical Engineers, North-Western Branch in the Conference Hall, Town Hall, Manchester), at 2.30 p.m.—Sir Wallace Akers: "Atomic Energy".

Physical Society (in the Small Physics Lecture Theatre, Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 5 p.m.—Mr. R. W. Cahn: "A New Theory of Recrystallization Nuclei"; Dr. K. J. Le Couteur: "The Evaporation Theory of Nuclear Disintegration".

Royal Institute of Chemistry, Manchester and District Section (in the Lecture Theatre, Gas Showrooms, Town Hall Extension, Manchester), at 6 p.m.—Major F. A. Freeth, F.R.S.: "The Art of Scientific Discovery".

Royal Institute of Chemistry, London and South-Eastern Counties Section (joint meeting with the London Section of the Society of Chemical Industry, at the Technical College, Brighton), at 7 p.m.—Dr. J. L. Edgar: "Modern Methods of Organic Solvent Manufacture".

Saturday, February 4

London County Council (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Mrs F. N. Betts: "The *Subansiri Area—Explorations among the Tribes of* Northern Assam".*

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Lecturer in Science (able to teach chemistry and biology, both at least to Intermediate B.Sc. standard) at Norwich City College and Art School—The Director of Education, City Hall, Norwich (February 4).

Senior Lecturer in Physical Chemistry—The Principal, College of Technology, Belfast (February 8).

Senior Principal Scientific Officer (male, with a good Honours degree in physics or mathematics, and experience in the application of physics to a wide range of problems) in the Safety in Mines Research and Testing Branch, Sheffield, under the Ministry of Fuel and Power—The Secretary, Civil Service Commission, Scientific Branch, 7th Floor, Trinidad House, Old Burlington Street, London, W.1, quoting No. 2938 (February 9).

Lecturer in Mechanical Engineering—The Registrar, The University, Sheffield (February 11).

Senior Experimental Officer at London Headquarters of the Ministry of Supply (duties include the co-ordination of thermionic valve requirements and supervision of an information service on valves)—The Secretary, Civil Service Commission, Scientific Branch, 7th Floor, Trinidad House, Old Burlington Street, London, W.1, quoting No. 2930 (February 14).

Professor of Pharmacognosy in Farouk I University, Alexandria—The Director, Egyptian Education Bureau, 4 Chesterfield Gardens, London, W.1 (February 15).

Lecturer in Bacteriology—The Registrar, King's College, Newcastle-upon-Tyne (February 18).

Lecturer or Assistant Lecturer in Plant Physiology or Cytogenetics—The Registrar, University College, Leicester (February 18).

Marine Zoologist (Senior Scientific Officer grade) in the Biological Section of the Ministry of Supply Division of Atomic Energy, Windscale Works, Cumberland—The Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting G.432/49A (February 18).

Principal Scientific Officer or Senior Scientific Officer at a Ministry of Supply Research and Development Establishment in Bucks, to control section studying problems of liquid rocket combustion chambers, atomizers, nozzles, etc.—The Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting C.476/49A (February 18).

Assistant Lecturer in Theoretical Physics (Honours graduate with special interest in Nuclear Physics)—The Registrar, King's College, Strand, London, W.C.2 (February 25).

Chemical Engineers (Senior Scientific Officer or Scientific Officer grade) at a Ministry of Supply Research and Development Establishment near London, for research on certain unit operations—The Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.936/49A (February 25).

Professor of Engineering—The Registrar, University College, Cathays Park, Cardiff (February 25).

Experimental Officers in Ministry of Supply Research and Development Establishments, chiefly in the Midlands and South England, and in the following fields: Chemistry (Ref. F.563/49A), physical, analytical (with special reference to modern techniques), organic and chemical engineering; Metallurgy (Ref. F. 563/49A); Physics (Ref. A.398/48A), particularly in its application to electronic or engineering problems including instrumentation; Aerodynamics (Ref. C.12/49A), including wind tunnel and flight work, subsonic and supersonic speeds; Aircraft Structural Theory (Ref. C.12/49A), including flutter and vibration, structural strength and airworthiness; Instrumentation (Ref. C.12/49A), including computing devices, control system, small servo and other mechanisms, optical and photographic research, aircraft instrumentation; Electronics (Ref. D 6/49A), applications to general research needs and computing devices, aircraft and weapon testing, aircraft navigation and landing devices; Radio and Radar (Ref. D.6/49A), particularly U.H.F. techniques, miniaturization aerial, design, circuit theory—The Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (February 27).

Scientific Officer at a Ministry of Supply Engineering Establishment in Southern England, to undertake advanced mathematical analysis and structural and mechanical design work on military bridging—The Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting C.30/50A (February 28).

Senior Lecturer in Physics in the University of Sydney—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Sydney, February 28).

Leverhulme Research Fellowships—The Secretary, Leverhulme Research Fellowships, 7 Bedford Row, London, W.C.1 (March 1).

Chair of Zoology—The Registrar, University College, Leicester (March 1).

Deputy Principal Inspector of Mechanical Engineering in Mines—The Secretary, Civil Service Commission, Scientific Branch, 7th Floor, Trinidad House, Old Burlington Street, London, W.1, quoting No. 2940 (March 2).

ASSISTANT AGRICULTURAL ECONOMISTS (2)—The Registrar The University, Manchester 13 (March 3).

LECTURER IN AGRICULTURAL CHEMISTRY—The Secretary and Registrar, University College, Bangor (March 4)

SENIOR SCIENTIFIC OFFICER at the Royal Aircraft Establishment, Farnborough, Hants, to take charge of section engaged on research and development work on parachute and allied problems—The Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.3/50 (March 4).

LECTURER IN AGRICULTURAL ECONOMICS—The Secretary, The University, Aberdeen (March 6)

I.C.I. RESEARCH FELLOWSHIPS in Biochemistry, Chemistry, Engineering, Pharmacology or Physics—The Secretary of University Court, The University, Glasgow (March 15).

SENIOR LECTURER OR LECTURER IN FOODS AND INSTITUTIONAL MANAGEMENT at the School of Home Science (University of Otago), Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (March 15).

READER IN ANTHROPOLOGY in King's College, Newcastle-upon-Tyne—The Registrar, University Office, 46 North Bailey, Durham (March 27).

LECTURER IN GEOGRAPHY in the University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (March 31).

LECTURER (Grade II) IN MECHANICAL ENGINEERING—The Secretary, The University, Birmingham 3 (March 31).

ASSISTANT LECTURER IN PHYSICS at the University College of the West Indies—The Secretary, Inter-University Council, 1 Gordon Square, London, W.C.1 (April 1).

SENIOR LECTURER OR LECTURER IN BOTANY (Plant Physiology) in the University of Melbourne—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (April 12).

TURNER AND NEWALL RESEARCH FELLOWSHIPS in Engineering, Inorganic Chemistry, Physics and allied subjects—The Registrar, The University, Manchester 13 (April 30).

ASSOCIATE PROFESSOR OR ASSISTANT PROFESSOR IN THE DEPARTMENT OF BOTANY (specialization: taxonomy and plant ecology)—Prof. W. Leach, University of Manitoba, Winnipeg, Man., Canada.

KEEPER OF THE YORKSHIRE MUSEUM, York—The Hon. Secretary, Yorkshire Philosophical Society, York.

PHYSIOLOGIST in the Endocrine Unit—The House Governor, London Hospital, Whitechapel, London, E.1.

STATISTICIAN (with Honours degree in statistics or similar qualification) for work in Singapore on the analysis and design of experiments on the physiological and psychological effects of extremes of tropical climate on human beings—The Medical Research Council, 38 Old Queen Street, London, S.W.1.

AGRICULTURAL ECONOMIST in the Department of Agriculture, Federation of Malaya—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

A Descriptive Guide to the Libraries of the University of Leeds. By Dr. Richard Offor. Supplement. Pp. 39. (Leeds: Brotherton Library, The University, 1949.) 1*s*. [1011

Ministry of Agriculture and Fisheries. Fishery Investigations, Series 1, Vol. 5, No. 1: Studies of the Scales of Young Salmon, *Salmo salar* L. (juv.), in relation to Growth, Migration and Spawning. By Dr. J. W. Jones. Pp. iv+23+2 plates. (London: H.M. Stationery Office, 1949.) 1*s*. 6*d*. net. [1011

British Cotton Industry Research Association. Shirley Institute Year Book. Pp. 112+6 plates. (Manchester: British Cotton Industry Research Association, 1949.) 5*s*. [1011

Proceedings of the Royal Irish Academy. Vol. 52, Section A, No. 15: Scattering by a Nuclear Potential. By L. Jánossy and J. McConnell. Pp. 203–222. 3*s*. Vol. 52, Section A, No. 16: Further Investigations on Proton Isobars in the Theory of Radiation Damping. By N. Hu. Pp. 223–252. 4*s*. 6*d*. Vol. 52, Section B, No. 6: Studies in Late Quaternary Deposits and Flora-History of Ireland. By Knud Jessen. Pp. 85–290+plates 3–16. 25*s*. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd., 1949.) [1011

Ministry of Fuel and Power. Reports of H.M. Inspector of Mines for the Year 1947, South Western Division. Report by T. A. Rogers. Pp. iv+60. (London: H.M. Stationery Office, 1949.) 1*s*. 3*d*. net. [1411

Department of Scientific and Industrial Research. Report of the Water Pollution Research Board, with the Report of the Director of Water Pollution Research for the Year 1948. Pp. iv+56. (London: H.M. Stationery Office, 1949.) 1*s*. 3*d*. net. [1411

Royal College of Surgeons of England. Scientific Report for the Year 1948–1949. Pp. 28. (London: Royal College of Surgeons of England, 1949.) [1411

The History of the Biochemical Society, 1911–1949. By R. H. A. Plimmer. Pp. 24+4 plates. (Cambridge: At the University Press, 1949.) 2*s*. 6*d*. net. [2211

Forestry Commission. Britain's Forests: Culbin. Pp. 16. (London: H.M. Stationery Office, 1949.) 6*d*. net. [2211

British Standard 1000: 1949, Universal Decimal Classification Complete English edition, 669: Metallurgy. Pp. 44. (London: British Standards Institution, 1949.) 10*s*. net. [2211

The Health of the School Child: Report of the Chief Medical Officer of the Ministry of Education for the Years 1946 and 1947. Pp. 151. (London: H.M. Stationery Office, 1949.) 3*s*. net. [2311

B.I.O.S. Surveys. Report No. 23: The Non-Ferrous Metal Industry in Germany during the Period 1939–1945. By Leslie Aitchison and Dr. Voya Kondic. Pp. 198. (London: H.M. Stationery Office, 1949.) 3*s*. 6*d*. net. [2311

Home Grown Threshed Peas Joint Committee. Fifth Annual Report, 1948–49. Pp. 16. (Peterborough and London: Home Grown Threshed Peas Joint Committee, 1949.) [2311

British Standard 809: 1949, Sampling Milk and Milk Products. Pp. 20 2*s*. 6*d*. net. British Standard 1581: 1949, Vitamin D in Oil for Poultry Feeding Purposes (Types 200 and 400). Pp. 10. 2*s*. net British Standard 1578: 1949, Rubbers for Milking Machines. Pp. 8 2*s*. net. (London: British Standards Institution, 1949.) [2311

British Social Hygiene Council. Educational Paper No. 4. Education for Family Life. By Eva M. Hubback. Pp. 19. (London: British Social Hygiene Council, 1949.) 1*s*. [2311

British Society of Animal Production. Report of Proceedings of the Tenth Meeting, 15th–18th August, 1948. General Topic: The Livestock of the South-West of England. Pp. 66+5 plates. 5*s*. Report of Proceedings of the Eleventh Meeting, 3rd March, 1949 General Topic: Increasing Beef Production in Britain. Pp. 56. 3*s*. (Edinburgh: Commonwealth Bureau of Animal Breeding, 1949.) [2311

Biological Staining Methods Compiled by George T. Gurr. Third edition. Pp. 28. (London: George T. Gurr, 136 New King's Road, S.W.6, 1949.) 1*s*. [2311

Leeds City Museums. Annual Report, 1948–49. Pp. 8. (Leeds City Museum, 1949.) [2311

Handbook of Departments in the University related to Industry (Published for the University Industrial Liaison Committee.) Pp. vi+57. (Edinburgh: James Thin, 1949.) [2311

Green Crop Dryers' Research Association. Year Book, 1949 Pp. 196. (London: *Farmers Weekly*, 1949.) 10*s*. 6*d*. [2411

Other Countries

Field Museum of Natural History. Zoological Series, Vol. 13, Catalogue of Birds of the Americas and the Adjacent Islands. By Charles E. Hellmayr and Boardman Conover. Part 1, No. 4 Cathartidae—Accipitridae—Pandionidae—Falconidae. (Publication 634.) Pp. vi+358. (Chicago: Field Museum of Natural History, 1949.) 4 dollars [1411

Deutsche Akademie der Wissenschaften zu Berlin. Veröffentlichungen des Geodätischen Institutes in Potsdam, Nr. 2. Der 24 m.-Interferenzkomparator des Geodätischen Institutes in Potsdam. Von F. Mühlig. Pp. iv+50. (Berlin: Akademie-Verlag, 1949.) 7 D. marks. [2211

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Proceedings of the American Academy of Arts and Sciences Vol. 77, No. 8: An Experimental Study of the Absolute Temperature Scale, 10, Comparison of the Scale of the Platinum Resistance Thermometer with the Scale of the Nitrogen Gas Thermometer from 0° to 444.6°, Reduction of the Observations. By James A. Beattie, Manson Benedict, B. Edwin Blaisdell and Joseph Kaye. Pp. 255–336. (Boston, Mass.: American Academy of Arts and Sciences, 1949.) [2211

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National Research Council of Canada. Review, 1949. (N.R.C. No. 1997.) Pp. 252. (Ottawa: National Research Council of Canada, 1949.) 75 cents. [2311

K. Svenska Vetenskapsakademiens Årsbok för år 1948: Minnesfesten över Berzelius, 20–22 September 1948. Pp. 56. (Stockholm Almquist and Wiksells Boktryckeri A.-B., 1948.) [2311

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University of Natal: Wattle Research Institute. Report for 1948 Pp. 26. (Pietermaritzburg: Wattle Research Institute, 1948.) [2311

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El Eucalipto en el Ecuador. Por Prof. Dr. M. Acosta Solis. Pp 52+10 plates. (Quito: Editorial 'Ecuador', 1949.) [2411

Plan sobre la proteccion y fomento Forestal del Ecuador. Por Prof Dr. M. Acosta Solis. Pp. 45. (Quito: Editorial 'Ecuador', 1949.) [2411

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UNIVERSITY AND TECHNOLOGICAL INSTITUTE

IF it were generally recognized that, for the technicians required in a modern State in very great numbers, technical training is all that is normally essential, and that even for some professions no more than technical training is necessary, we should be much nearer a generally acceptable solution of the problem of the right balance between the universities and the technical colleges. Such technical training is not the function of the universities, and will continue to be given by the technical colleges and other professional or specialized institutions independent of how far they contribute also to technological education. The question as to what technological studies meet the criteria that have been suggested for university courses must be left to the universities themselves to determine; but whether such education is given by university departments or by institutes of technology it must be recognized that such courses have the character of university courses in respect of the intellectual discipline they demand. There can be no suggestion that the degrees or diplomas obtained on completing such courses are in any way inferior to those obtained as the result of study in the more academic fields at a university.

Once that is made clear, there should be little danger of serious disagreement. Contributors to a discussion on this issue in *The Times* arising out of a report of Sir John Anderson's speech at the Foundation Day celebrations of the University of London on November 25 were all concerned that the study of technology should be based on the best teaching of fundamental science, and that there should be no creation of technical colleges less well endowed and less self-governing than a university. As Lord Eustace Percy pointed out, to propose the foundation of an institute of technology on the Massachusetts or California model, or a Technische Hochschule on the Continental model, is to propose the foundation of a university, and it is significant that the German Commission on University Reform discusses this subject under the title "Technical Universities". The broad argument of that section of the report may be appropriately recalled here. It is argued that such universities have the same type of constitution and organisation as ordinary universities; research and teaching are closely associated; the task of education in its specifically academic character is the same for both; and both have the task of providing a sound professional education, though for the technical universities, professional training stands in the foreground. While universities must take account of technology in their research and teaching, the technical universities must weave technical subjects into a general structure of Western humanistic thought, and the German Commission recommends that this should be done by adding a new humanistic-sociological faculty. The Commission recognizes, too, that a beginning must be made in the secondary schools if the essentials of the spiritual heritage of the West are to be transmitted to technical students, and it accepts the view that the technical universities have an almost greater interest than the universities themselves in a reform of the whole educational system.

These views are not without their bearing on the whole question of the training of technologists in Great Britain also. If we are to avoid the narrow specialism and to inculcate the wide outlook which is universally desired in the technician and technologist as well as in the academic graduate, a beginning must be made in the schools: the whole task cannot be left to the universities, still less to the technical colleges and institutes of technology. That in itself might be a first step towards the modification of university courses and the freeing of the universities, as Sir John Anderson said, from duties which could with greater advantage be undertaken by other types of institution. It should be remembered, too, that even if the technological faculties were entirely divorced from the universities, the overcrowding which threatens the maintenance of standards would not necessarily be removed, for less than one-seventh of the university students of Great Britain are studying applied science in some form.

The question of where technological education is best conducted is, in fact, to be decided on practical grounds, once regard has been had to the fundamental questions of the extent of the demand and the criteria for university and technological courses. The cost of equipment and of the conduct of technological research and the best means of budgetary control are important factors, as Prof. A. R. Ubbelohde has indicated, in determining whether to create a series of new institutes or expand, or create new, university departments. Questions of staffing are also important. Above all, it is imperative not merely that there should be the closest possible relations between the universities and the institutes of technology and technical colleges, but also that development and expansion should be planned under the guidance of a single authority like the University Grants Committee, which will take a national rather than a sectional or local view. Such a body can make the most effective representations to secure that the secondary education system also is adapted to assist in supplying the country with men and women of the wide and tolerant outlook and understanding which are now required in its scientific workers, technologists, technicians and other professional workers.

Prof. M. L. Oliphant, in his article on "University or Institute of Technology?" in the *Universities' Quarterly*, expresses his conviction that the applied sciences as at present taught and developed are out of place in a university. He finds it difficult to reconcile his idea of a university—its mission "to guard jealously scholarship and knowledge and to preserve the freedom to gather fresh knowledge as and where inspiration comes"—with the type of vocational training usually given in the various branches of engineering and technology. The attempt to teach engineering in a university is regarded by him as unrealistic, for no university can hope to possess equipment which is adequate for the purpose or which remains up to date and is in line with that used in industry. That might be remarked of most technical colleges as well; and for the increasing application of science and the scientific method to industry and to the human problems associated with a high level of production, we must look less to the universities as such than to separate institutions, possibly attached to the universities, or to industry itself, where applied science can be added to a sound background of fundamental knowledge.

The provision of institutions devoted primarily to the practical aspects of applied science, loosely attached to universities and located on or near the university sites, would obviate some of the difficulties which attend the teaching of applied science inside the universities and provide a healthy climate for the proper development of both higher education and research in the technological field. Institutions of the character conceived by such protagonists as Lord Eustace Percy, Lord Cherwell, Sir Ernest Barlow, Prof. Oliphant, Sir John Anderson and others and where instruction is given in the way advocated by Mr. Eric James, highmaster of the Manchester Grammar School, would be essentially universities themselves. They should be able to supply the nation with technologists in no way inferior in the width of their outlook to those who receive the more academic training of the universities. The provision of quantitative data on the probable demand for specific categories of professional men and technologists, as are given in the series of brief reports on the present and future supply and demand "for persons with professional qualifications" being issued by the Ministry of Labour and National Service, should at least make it possible to plan the consolidation of university expansion with the development of technological education and of the technical colleges. By such means it should be possible to ensure both the maintenance of university standards and the efficient use of resources of equipment and trained man-power; and also to provide the men and women upon whose efforts and ability the maintenance of the material and intellectual standards of life in Great Britain depend.

CENTENARY OF THE SECOND LAW OF THERMODYNAMICS

Thermodynamics

An Advanced Treatment for Chemists and Physicists. By Prof. E. A. Guggenheim. (Monographs on Theoretical and Applied Physics, Vol. 2.) Pp. xxiii+395. (Amsterdam: North-Holland Publishing Co., 1949.) 20 f.

It is almost exactly a hundred years since what is now known as the second law of thermodynamics was formulated. The honour of first making the general statement that "heat cannot of itself pass from a colder to a hotter body" falls to Clausius, in a memoir of which the substance was communicated to the Berlin Academy of Sciences on February 18, 1850, and which was published in *Poggendorff's*

Annalen in April and May 1850. More than one attempt was being made to reconcile Carnot's theory of the heat engine with the newly discovered equivalence of heat and work. Helmholtz had enunciated the first law or principle of the conservation of energy a few years before. W. Thomson (Kelvin) had become acquainted with Carnot's memoir while in Paris several years earlier, and in 1849 had published in the *Transactions of the Royal Society of Edinburgh* a lengthy description of the Carnot cycle; but he failed at this time to discover the general relation or to recognize that the work obtained is the difference between the heat taken in and that given out.

This was clearly understood by Clausius. "It is not even necessary to cast the theory of Carnot overboard," he says. "On a nearer view of the case we find that the new theory is opposed, not to the real fundamental principle of Carnot, but to his addition 'no heat is lost', for it is quite possible that in the production of work both may take place at the same time; a certain portion of heat may be consumed and a further portion transmitted from a warm to a cold body and both portions may stand in a certain definite relation to the quantity of work produced."

W. J. M. Rankine had arrived at similar results in a memoir "On the Mechanical Action of Heat", which was read to the Royal Society of Edinburgh on February 4, 1850. He says: "No mechanical power can be given out in the shape of expansion unless the quantity of heat emitted by the body in returning to the primitive temperature and volume is *less* than the quantity of heat originally received . . . the sum of the *vis viva* in the two forms continues unchanged". Rankine's ideas were based on a rather special theory in which heat was regarded as due to the rotation of atomic vortices and do not therefore have the generality of Clausius's treatment, but he does give 'a thermodynamic function' which was later named entropy.

Thomson's mind was evidently working on similar lines and, a year later, in 1851, giving the fullest priority to Clausius and Rankine, he published the first part of his memoir "On the Dynamical Theory of Heat", in which the second law is stated in the words: "It is impossible, by means of inanimate material agency, to derive mechanical effect from any portion of matter by cooling it below the temperature of the surrounding objects". In the following year (April 19, 1852) he read to the Royal Society of Edinburgh his paper "On a Universal Tendency in Nature to the Dissipation of Mechanical Energy", in which the second law appears in its fullest generality:

"1. There is at present in the material world a universal tendency to the dissipation of mechanical energy.

"2. Any *restoration* of mechanical energy, without more than an equivalent of dissipation, is impossible in inanimate material processes, and is probably never effected by means of organised matter, either endowed with vegetable life or subjected to the will of an animate creature.

"3. Within a finite period of time past, the earth must have been, and within a finite period of time to come the earth must again be, unfit for the habitation of man as at present constituted. . . ."

It was thus Thomson's particular contribution to see the universal consequences of the law. As Helmholtz said later in one of his popular lectures, "We must admire the sagacity of Thomson, who in the letters of a long-known little mathematical formula, was able to discern consequences which threatened the universe, though certainly after an infinite period of time, with eternal death".

To complete the story, in 1865 Clausius arrived at the alternative general formulation: "The energy of the Universe is constant: its entropy tends to a maximum"; and ten years later Gibbs deduced in great detail the consequences of this, as applied to the equilibrium of heterogeneous systems.

A long period followed in which many of the results obtained by Gibbs were rediscovered piecemeal by the use of painfully 'eccentric cycles' and a cumbrous apparatus of pistons, cylinders and semipermeable membranes. The establishment of accurate methods of determining thermodynamic functions of actual systems was due to a great extent to the work of G. N. Lewis and his school in the early years of this century. The main progress since then has been the correlation of the thermodynamic and statistical approaches to equilibrium which has been achieved and systematized by Darwin, Fowler and Guggenheim, and the elucidation of: (*a*) the low-temperature phenomena which were originally described in Nernst's third law of thermodynamics, but as is now well known are only satisfactorily described in terms of the statistical method, and (*b*) the entropy constants of gases.

All these developments are fully discussed in the monograph which provides the occasion for these remarks, which is one of the most comprehensive accounts of 'classical thermodynamics' which has ever been written. It is described as "an advanced treatment . . . written for graduates". The assumption of previous knowledge permits Prof. Guggenheim to plunge at once into the subject in a completely logical and non-historical fashion, rejecting the use of what he describes, in G. N. Lewis's phrase, as "cyclic processes limping about eccentric and not quite completed cycles". Students who have acquired the necessary preliminary equipment, which permits them to study the subject in its most abstract and general form, will find it an admirable guide. At first sight it may appear to be severely mathematical, but the mathematical difficulties are more apparent than real, and any student who has the patience to study the subject thoroughly will find in this book a lucid guide in which, unlike in most other treatises, the emphasis is on first principles, and the logical basis is always stressed and frequently illuminated.

If the book has a fault it is in being too comprehensive. It leaves little to the student, who will rarely have the fun—which so many of us have experienced—of discovering relations which are later found to be in Gibbs or elsewhere. In the presence of so much excellence, it would be ungenerous to quibble over small points; but the writer may perhaps be permitted to express the hope that Guggenheim's naming of the principle that "if two systems are both in thermal equilibrium with a third system, then they are in thermal equilibrium with each other", as the "zeroth principle of thermodynamics" will not be generally adopted.

The book is beautifully produced, and though its appearance at this time is, no doubt, a coincidence, it is, in fact, a timely memorial, since it offers a reasoned and critical account of the results of the first hundred years of the laws of thermodynamics.

J. A. V. Butler

ESSAYS ON HUMAN AFFAIRS

Creative Man

And other Addresses. By Viscount Samuel. Pp. vii+141. (London: Cresset Press, Ltd., 1949.) 9*s*. 6*d*. net.

THROUGH almost all the addresses which are here collected under the title "Creative Man" runs one theme very similar to that which inspired Lord Samuel's Messel Lecture, "Science and Civilization", in July 1940. Here again are the conception of the whole welfare of man in all its fullness, spiritual and intellectual, individual and social, the same appreciation of the importance of research, its encouragement and rightful use, the clear realization of the limitations as well as of the values of science, the emphasis on individuality and freedom, and the conviction that means matter as well as ends, and that while the material cannot be allowed to dominate, it must not be ignored. Man's supreme need is for a moral basis of society, a loftier ethic, fostering thought and learning, and bringing tranquillity and peace.

To the question whether our will can rise to match our opportunity, Lord Samuel gives no more decided answer in these later addresses than in his earlier lecture. He claims to be neither optimist nor pessimist but, quoting George Eliot's answer, regrets that the term meliorism, meaning that, on the whole, things are better now than they have been in the past and might be better still in the future if we made the necessary effort, has not come into common use. Lord Samuel's mind is occupied with the need for a drawing together of philosophy, science and religion in order to offer the world a way of escape, as is brought out particularly in his Romanes Lecture (from which the book takes its title), or in that on science and philosophy, delivered before the British Association, and in his presidential address to the Royal Institute of Philosophy in October 1948, "Decline or Revival of Religion".

This last-named address, with the short broadcast on Francis Bacon, given in 1947, is the only material printed here for the first time; but the addresses read now with the same charm and persuasiveness as when they were delivered, and some of their observations are even more needed. In 1941, in his Herbert Spencer Lecture entitled "Democracy: its Failings and its Future", Lord Samuel said: "There are things that matter more than good administration —liberty matters more, and social justice; and these depend largely on the kind of government that there is". The truth of that observation has been emphasized by much hard experience, even in the world of science, in the past eight years. In the same lecture, urging that the State should try more to make public service easy, Lord Samuel anticipated an important point made by Lord Beveridge in his report on "Voluntary Action" and which is exercising the minds of all concerned with the future of local government, for example. Again, his definition of liberty as that men should be free to do what they will, only provided that they do not interfere with the equal freedom of others, is reflected in current discussion on human rights, just as its elaboration into the general principle that we should tolerate everything except intolerance and that liberty should suppress nothing except attempts at its own suppression anticipate an important argument of Mr. Middleton Murry in "The Free Society".

Delivered to diverse audiences, these addresses read well. They seem to retain something of the perennial freshness of the Elizabethan thinker and essayist to whom in one of them Lord Samuel pays tribute. If indeed this volume contains Lord Samuel's final word, its mellow wisdom, magnanimity and easy diction make it a charming valediction.

R. BRIGHTMA

BRITISH MAMMALS

Mammals in Britain

By Michael Blackmore. Pp. 128 (77 plates). (London and Glasgow: Wm. Collins, Sons and Co., Ltd., 1948.) 15*s*. net.

MICHAEL BLACKMORE has written an enjoyable book on mammals in Great Britain and has gathered, from various sources, a remarkable collection of photographs, some of great beauty. One of the most notable is that of a blue hare half hidden in its snow tunnel; this photograph was, I believe, taken in Strathspey. We are told interesting facts about British mammals, some of the animals being extinct. We know that the brown rat is an undesirable immigrant, but most of us were under the impression that the black rat, the old English black rat, as it is often called, is a firm resident. Yet we now learn that it also is an alien; for, writes the author, "it probably arrived in the thirteenth century". He states that rabbits probably existed in Britain in prehistoric times; but the race disappeared during the glacial period. He considers that the present rabbit stock probably dates from the twelfth century. The grey squirrel was introduced in 1889.

In England the bear was exterminated before the tenth century. Tradition, Mr. Blackmore states, records that the last bear was killed in Scotland in the year 1057. The Norse name for bear occurs in Bernera—the name of several islands of the Outer Hebrides. It is possible that these place-names commemorate actual bears during the Norse occupation of those islands, which began in the ninth century and lasted until 1263; but the Celtic scholar, the late Prof. W. J. Watson, inclined to the belief that here the word Bjorn, a Bear, was a man's name. We learn that reindeer (there is now talk of re-introducing them on a peninsula in the west of Ross-shire) were still in Scotland towards the close of the twelfth century. Perhaps the last beaver record is in the year 1188, in Wales. Wolves survived in the Scottish Highlands until the seventeenth century; tradition avers that large areas of the Old Caledonian Forest of Scots fir were burned to drive out the wolves. On p. 23 the author states that the hedgehog is easily tamed, and records one which used to snore contentedly by the kitchen fire. The dog of the house at first disliked the hedgehog, but later the two became friends.

There is an interesting chapter on British bats, of which there are twelve species. On p. 27 the author discusses the theory that bats in flight avoid obstacles by a form of radar. Writing of those rare mammals, the marten-cat and the polecat, he makes the interesting statement (p. 48) that the only flesh-eating mammal protected by law in Britain is the Atlantic or grey seal. It seems time that the rare marten should also be given protection.

SETON GORDON

Les molécules géantes et leurs applications

Par Georges Champetier. (Bibliothèque d'éducation par la science.) Pp. iv+459. (Paris : Albin Michel, 1948.) 720 francs.

"MANY of the polymers being examined to-day have been obtained in the past ; but the workers who made them did not call them polymers. They called them something quite different and threw them down the sink." This remark, made by Dr. A. S. C. Lawrence in *Science Progress* in 1934, finds an echo in the introduction of M. Georges Champetier's book. The curious reader of chemistry will find ample reason in this book for the scientific world's altered attitude to macromolecular materials, in spite of certain qualities that they have which are repulsive to a truly refined organic chemist. The book is not intended for the hardened polymer expert ; for it is extensive rather than intensive. It gives no references to original papers ; instead there is a bibliography of more specialized books (from which Staudinger's historically fundamental "Die Hochmolekularen Organischen Verbindungen" is a rather notable absentee).

But M. Champetier's book is remarkably comprehensive in scope. Part 1 describes the general constitution and properties of macromolecular compounds, covering, *inter alia*, the estimation of their molecular weights, investigation by X-ray and other physical methods, their chemical properties, swelling and colloidal properties, and mechanical and physical properties. Part 2 deals, in turn, with a large number of individual polymers, starting with inorganic macromolecules (including carbon, phosphorus, sulphur and crystalline materials, as well as the silicones), going on to organic polymers, vinyl, rubber-like, polycondensed, multi-dimensional, and drying oils ; and closing with an account of biological macromolecules—carbohydrates and proteins. The whole furnishes an informative survey of the scientific aspects of polymers, without losing sight of their technical uses. G. W.

Comparative Anatomy

An Introduction to the Vertebrates. By Leverett A. Adams and Samuel Eddy. Pp. vii+520. (New York : John Wiley and Sons, Inc. ; London : Chapman and Hall, Ltd., 1949.) 30*s*. net.

THIS text-book of comparative anatomy is an expansion of Prof. L. A. Adams's earlier work on vertebrates. With the assistance of Prof. S. Eddy he has rearranged the material, added to and corrected the text, and incorporated new facts and ideas. The result is a readable and informative book, suitable for advanced students of the post-intermediate grade. The first five chapters make up Part 1, and contain a systematic review of the vertebrates and a short chapter on their embryology. The second part, with twelve chapters, deals with a comparative study of the systems of the body and is orthodox in treatment. There is a good bibliography. A glossary of zoological terms has been added, and the index is adequate.

The illustrations are clear and well chosen, especially those by K. H. Paul, and the plain lettering might be imitated with advantage in text-book illustrations in Great Britain. Some figures, however, are not so reliable. For example, no size or magnification is given in the sketches of animals in the first part of the book, and the student may infer that *Neoceratodus* is smaller than the frog, and *Archæopteryx* larger than the cassowary. In the diagrams of the vascular system of the frog (Fig. 244), the pulmo-cutaneous artery is wrongly drawn on the dorsal side of the aortic arch, and this is repeated in Fig. 247 for the reptile. In Fig. 245, for post-cardinal read post-caval, and in Fig. 258 the precaval system is that of the Urodele and not of the Anuran, though the diagram is labelled frog. Why are the large dorso-lumbar veins omitted from all these figures ? With these and a few minor corrections in the text, the book can be recommended. Production and printing are excellent.

Functional Localization in the Frontal Lobes and Cerebellum

Being the William Withering Memorial Lectures delivered at the Birmingham Medical School, 1948. By Dr. John F. Fulton. Pp. xii+140. (Oxford : Clarendon Press ; London : Oxford University Press, 1949.) 15*s*. net.

THIS, the reporting of the William Withering Memorial Lectures in monograph form, has made available a concise, very readable and up-to-date exposition on what are the functions of the frontal lobe. This—coming as it does from one of the world's foremost experimental neurophysiologists—has the stamp of authority.

The author pays tribute to the pioneer work of Yerkes for his animal-training experiments ; also to Victor Horsley and Harvey Cushing for the foundation of the neurosurgical approach. He discusses neurosurgery in its efforts to treat emotional states and the chance discovery of its relief of intractable pain. He believes that with increasing research work, the operation of lobotomy will become much more selective and thereby reduce the undesirable destruction which occurs at present.

The last part of the book is devoted to the cerebellum reconsidered, and points out that, with modern investigation, localization in this part of the brain is highly developed. The debt modern knowledge owes to the technique of physiological neuronography begun by De Barenne is acknowledged.

This fascinating book should be read by every student of neurophysiology, whether he be laboratory worker, clinician, psychiatrist or neurosurgeon. A very complete bibliography is appended to each section of the book.

A History of Oto-Laryngology

By Dr. R. Scott Stevenson and Dr. Douglas Guthrie. Pp. vii+155+30 plates. (Edinburgh : E. and S. Livingstone, Ltd., 1949.) 17*s*. 6*d*. net.

THE immediate stimulus for the writing of this interesting book was the International Congress of Otolaryngology in London in 1949. The text is fascinating, most especially to those who practise the speciality, but it should prove of great value to those interested in medical history generally. One finds that two of the most important discoveries in the development of the speciality owe their origin to the work of a postmaster and a singing teacher.

The illustrations are well chosen and show that much research has gone into the development of this small, quite readable book.

The chapter on education of the deaf is full of information which should appeal to the social worker and educationist.

The bibliographical details at the end of the book are very adequate.

Human Relations in Modern Industry

By Dr. R. F. Tredgold. (Social Science Studies.) Pp. 192. (London: Gerald Duckworth and Co., Ltd., 1949.) 8*s*. 6*d*. net.

It is recognized by all who hold responsible positions in industry that the biggest industrial problem to-day is not technological but human. In the drive for productivity a great deal of thought is being given to the means of making all work more effective rather than more arduous. The methods used include schemes to enable management and workers to work for the common purpose of the greatest possible efficiency in the particular industry. Out of these schemes has grown the study of what is popularly called human relations in industry and, in this book, R. F. Tredgold discusses those factors which he believes will make for friendly spirit and concerted effort by both sides in industry. His suggestions are based on a series of lectures which were given at the Roffey Park Rehabilitation Centre and where he himself, in his capacity as psychiatrist, was able to re-orientate the attitudes of many industrial workers whose emotional balance had become upset.

Tredgold's ideas are put forward in no dogmatic way and stand almost as subjects for discussion similar to those thrown out at Roffey Park. His psychological analyses of behaviour, why people work, the essentials and teaching of leadership contain little new or original, but the book has value in presenting current ideas on human relations in industry in a clear, positive and interesting way. The author is happiest when dealing with such topics as the significance of neurosis in production, early signs of mental disorder and problems of individuals, and for these chapters alone the book merits study by industrial executives and others whose work involves getting the best out of people with whom they have to work. T. H. H.

Industrial Rheology and Rheological Structures

By the late Henry Green. Pp. xii+311. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1949.) 44*s*. net.

The late Henry Green was best known to older rheologists for his work with E. C. Bingham in the early twenties and to younger people for his quite recent contributions, in collaboration with Miss R. Weltmann, to the theory and measurement of thixotropy. During the intervening period, he published little on rheology. Time will probably show that his main contribution lay in his insistence that, wherever possible, rheological phenomena should be followed under the microscope. In many cases, rheological theory has to account for behaviour at a molecular level; but there are occasions when the structural units are of microscopic size, and Green rightly insisted on making use of this fact whenever possible. Consistent with this liking for direct observation was his extremely practical attitude to rheology as a discipline. In this posthumous book he tells the reader very directly that his aim is "to give the laboratory man a workable rheological system", and he has appendixes "for the laboratory investigator" and "for the laboratory director" which are full of sound common sense.

The book is described on the cover as "A manual and practical working guide", but in this capacity it must be viewed with caution. There are too many errors and inexactitudes for it to be a reliable source of information for those unfamiliar with rheological theory. This is particularly true of the glossary, in which the definitions of such terms as elastic deformation, laminar flow, specific viscosity and stress are definitely misleading. The treatment of tack, also, is very much over-simplified. The book describes in some detail that part of rheology of special interest to the author, and could only serve as a "practical working guide" if read in conjunction with other books covering a wider field from which the information given could be checked and amplified.

G. W. Scott Blair

Quantitative Analysis

By Prof. Willis Conway Pierce and Prof. Edward Lauth Haenisch. Third edition. Pp. xiv+520. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1948.) 22*s*. 6*d*. net.

This is a student's text-book designed for a one-year course of laboratory work in volumetric and gravimetric analysis. Each section is introduced by a discussion of theory and general principles. Detailed experimental instructions are given, followed in each case by explanatory notes. A number of questions and problems are provided at the end of each chapter.

More than half the book is concerned with volumetric methods, and most of the more familiar of these are described, including the use of oxidation-reduction indicators and electrometric end-points. Gravimetric processes are then introduced, culminating in the complete analysis of a limestone and a brass, a determination of copper by electrodeposition being included. The experimental methods described are up to date, and due attention is given to the assessment of errors and their origin. The book concludes with a chapter on the use of the original literature and a bibliography of reference works.

The work of the college lecturer will be considerably lightened by the use of this volume, which provides an excellent and stimulating guide for the student.

Bird Life

By Edward A. Armstrong. Pp. xi+152+26 plates. (London: Lindsay Drummond, Ltd., 1949.) 12*s*. 6*d*. net.

Edward Armstrong has already made a name for himself as an able writer on birds and bird matters, and this latest volume from his pen, "Bird Life", will enhance his reputation for charm combined with accuracy. He covers a wide field: such diverse matters as migration, defying foes, the "Language of Birds", deluding enemies, and birds and men, are some of the many topics he deals with.

Under the heading of "Deluding Enemies", the author has some interesting remarks to make on the "injury-feigning" behaviour of birds. He says: "'Injury-feigning' in many birds seems to have arisen as 'betwixt and between' behaviour, when the bird wanted to flee and also wanted to look after the eggs or young. In the fable, Buridan's ass died because it could not decide which of two exactly equal piles of hay to eat. It seems in the past birds sprawling about, due to the conflict of mother-love and fear in their hearts, accidentally decoyed animals away from their nests and so left more descendants than those which fled leaving their treasures at the enemy's mercy or remained to be seized on the nest.' So 'injury-feigning' behaviour became fixed and inherited."

Mention must be made of the excellent photographs that illustrate this book and the many delightful drawings by Dr. Ennion. Frances Pitt

THE AUSTRALIAN NATIONAL UNIVERSITY

A PROJECT IN RESEARCH

By Prof. DOUGLAS B. COPLAND
Vice-Chancellor of the University

ON October 24, 1949, the ceremony took place in Canberra of laying the foundation stones of the first three main buildings of the Australian National University. The Prime Minister (the Right Hon. J. B. Chifley) laid the foundation stones of the John Curtin School of Medical Research (so named in honour of the former Prime Minister) and the Research School of Physical Sciences, and the Minister for Post-War Reconstruction (the Hon. J. J. Dedman) laid the foundation stone of University House, a residential college designed to combine features of the English college and the American faculty club. Mr. Chifley and his colleague Mr. Dedman have given great support to the establishment in Canberra of a university at the postgraduate level on lines that mark a departure from the traditional development of universities in the younger countries.

Naturally, the ceremony of laying foundation stones was preceded by much planning. The new University derives its authority from an Act of the Commonwealth Parliament passed in 1946 and providing for both undergraduate and graduate work. There is in Canberra a small but developing University College affiliated with the University of Melbourne which may under the Act be incorporated by the Australian National University. But the Act also provides that the new University may develop graduate studies and research and mentions in particular four Schools, namely, Medical Research, Physical Sciences, Social Sciences and Pacific Studies. It is in these four Schools that the University will concentrate its efforts in its early years; no action will be taken to incorporate the College or to develop undergraduate work until the research schools are fully established.

The Act provides for a Council to manage the University much on the lines of that of a provincial university in the United Kingdom or the universities already established in Australia; but the Council will not be established until the University has a convocation of at least fifty members from which to elect a proportion of the Council. Meanwhile, there is an Interim Council appointed by the Governor-General in Council, but selected so as to give a reasonable balance among academic, official and parliamentary members. The Interim Council has nearly all the powers of the duly constituted Council, and is free to manage the affairs of the University within the wide terms set by the Act. Its first decision was to concentrate upon the work of the four Research Schools already mentioned. The Act provides that after July 1, 1951, a sum of £325,000 will be made available annually for the current expenses of the University, and the Interim Council has laid its plans to absorb the whole of this grant in developing the four graduate Research Schools and the accessories necessary for them, including the establishment of a National University Library. Separate financial provision has been made for the building of the necessary laboratories, the residential college and the beginnings of the library. The residential college (University House) has already been commenced on the site in Canberra, and building operations are about to start on the laboratory for the Research School of Physical Sciences, while the plans for the School of Medical Research are at an advanced stage. The Library is being collected in its first stages in Melbourne, and will later be transferred to Canberra.

The site is an area of some 250 acres in the heart of Canberra, on perhaps the most attractive situation in the developing capital city. Some office buildings are already on the site, and a few houses. These buildings will gradually be made available to the University for administrative offices, temporary library accommodation and working accommodation for the Research Schools of Social Sciences and Pacific Studies. The building plans are being developed with an eye to the future, and in the long run all the existing buildings will be replaced by new construction specially designed for university purposes and consistent with the architectural requirements of a modified early Colonial design. The founders of the University will see only the beginnings of the master plan, and the best they can hope for is that they will not be accused by the generations to come of lack of imagination in the basic design or the magnitude of their plans.

Emphasis on research does not mean that the University will be without a vigorous student body. It will have a group of graduate scholars selected on grounds of proved competence in scholarship, and working for their doctorate degrees. The ratio of student scholars to staff, however, will be much lower than in the normal university, even where postgraduate studies predominate. In the early years there will be no undergraduates; and if later there is provision for undergraduate teaching, it will not interfere with the work of the Research Schools. These are designed to combine research at a high level with the training of research scholars. The permanent staff is to consist of the Directors of the Research Schools, probably five Professors in each School, and a group of Readers and a few permanent Fellows. At the other end will be the graduate scholars, drawn, it is hoped, from the graduates of overseas universities as well as of the Australian universities. In between will be two grades of research fellows, designated Research Fellow and Senior Research Fellow. They will be awarded fellowships, in each case for three years and renewable for two more years on the ground of special competence in research; but it is not intended that they should remain as permanent members of the staff or workers of the University, except in the few cases where they may succeed to readerships or professorships. It is expected that these Research Fellows will be given the opportunity of pursuing their researches under suitable conditions, will participate in the training of the graduate scholars, undertake some lectures or seminars in the other universities, and on completion of their work will be available for higher positions in other universities or in research institutions. They will be a vital force in the University, and it is important that there should be a regular inflow of them. They will have a stimulating effect on their seniors as well as their juniors.

The question may be asked: Why a National University? The main answer is to be found in the increasing interest of the Australian Commonwealth Government in applied research through the Commonwealth Scientific and Industrial Research Organisation, on which the annual expenditure has now reached £2 million, and in the pressing need for fundamental research. Since 1936 the Commonwealth has made a direct grant annually for research to the universities of Australia. This commenced at £30,000 and has grown now to £100,000. It is used for promoting postgraduate research in the universities and, though insufficient, it has been a great stimulus to postgraduate studies. But there was need for a more concentrated attack on higher research, that would give the best products of the universities opportunities for further training and research. This will be one of the main tasks of the National University, and its work cannot but strengthen the graduate studies of the other universities in Australia. On the undergraduate level, specialized training for administrative work is necessary in the expanding functions of the Commonwealth, apart from the need for degree courses for officers of the Government and residents of Canberra. These are being provided by Canberra University College, and will continue to be so provided; but in the long run they may be developed in the National University.

In the plans for the development of the new University the experience and guidance of established scholars operating in the four fields in which the University will commence its activities have been drawn upon. An Academic Advisory Committee in the United Kingdom has been established to act as the academic board of the University. This Committee consists at present of three distinguished Australians: Sir Howard Florey of Oxford in medical research, Prof. Marcus Oliphant of Birmingham in physics, and Prof. K. C. Wheare of Oxford in the social sciences, and of one New Zealander, Prof. Raymond Firth of London in Pacific studies. This Committee has rendered great service to the University in its early plans, and has enabled it already to gather the nucleus of a body of distinguished academic men to commence its work. Seven professors have been appointed and some are already at work, though not yet in Canberra. Prof. Oliphant has accepted the office of director of the Research School of Physical Sciences and expects to arrive in Canberra early in 1951 to commence the installation of equipment for the laboratory. Directors for the other Schools have not yet been appointed; these Schools are being developed under the guidance of the other members of the Academic Advisory Committee already mentioned. The Interim Council plans to build up gradually the permanent staff, so that when the facilities are available in Canberra it will be possible to assemble staff and scholars there without delay. This will be done during 1951, and by the end of that year the University should have a considerable academic body at work in Canberra. There will be more delay in starting work in the Medical School in Canberra than in the other Schools, because of the extensive plans and preparations required for the medical laboratory.

The scope of the work is perhaps more extensive than the definition of the Research Schools suggests. In medicine, all phases of non-clinical research will be undertaken, including chemistry, biochemistry, microbiology, pathology, physiology and pharmacology. In physics the emphasis will be on nuclear physics, but work in astrophysics and radiophysics will be developed in co-operation with other research institutes now at work in Australia. The Research School of Social Sciences will embark on a comprehensive attack on all phases of social science, including history, economics, political science, social philosophy and law. A somewhat novel feature of the work of the University will be the Research School of Pacific Studies, which will attempt a concentrated study of the political, social and international issues in the Pacific area; the specific departments of study to be organised include anthropology, Pacific history, political science, geography, demography and international relations.

In all phases of its work the new University will co-operate actively with the other universities of Australia. Its staff will be available to undertake short lecture courses or seminars in those universities, and its facilities at Canberra will be available to staff and scholars of other universities. This contact will be mutually advantageous, especially for the National University, in giving its staff experience and some obligations in teaching, without which it is doubtful whether research at a high level can be maintained. The Australian National University has already brought to Australia some distinguished scholars as visiting professors from Great Britain, Canada and the United States. These scholars have spent most of their time in the other universities, not so much giving formal lectures as meeting staff and advanced students informally, and this has proved a great advantage. It is hoped that this activity will be maintained even when the University is in full operation at Canberra.

FLAME SPECTRA*

By Dr. A. G. GAYDON

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THE most obvious distinction between combustion and other chemical processes is the appearance of a flame, that is, the emission of light. The study of the quantity and quality of this light—the study of its spectrum—is of interest for at least three reasons. First, the spectra obtained are of interest for pure spectroscopy; many of the band systems seem to be peculiar to flames; for example, the bands of IO, BrO, ClO and Dr. W. M. Vaidya's hydrocarbon flame bands of HCO, and their study yields information about the structure of these radicals. Secondly, information about the combustion processes themselves may be obtained; in the reaction zone of hot flames of pre-mixed gases the time in which the reactions take place may be less than a millionth of a second, and chemical sampling under these conditions is impracticable, whereas the spectra do give some information about what intermediaries are formed. Thirdly, we learn about processes of energy transfer from one molecule to another on collision; indeed, flame spectroscopy may be regarded as a sort of inverted photochemistry—in photochemistry we use light to produce chemical reactions, whereas with flames chemical reaction gives light.

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* Summary of a Friday Evening Discourse given at the Royal Institution on November 11. For further details of this work, reference may be made to "Spectroscopy and Combustion Theory" (A. G. Gaydon, 2nd edition, 1948) and to recent papers by Gaydon, A. G., and Wolfhard, H. G., *Proc. Roy. Soc.*, A, **194**, 169 (1948); **199**, 89 (1949); and in the press.

The majority of flames are rather weak sources of light, and the spectra are usually studied photographically. An oxy-acetylene flame is, however, sufficiently bright for the spectrum to be projected, and it may readily be seen that it consists of a number of bands. The Swan system of bands of C_2, diatomic carbon vapour, are the strongest feature, and the bands of CH in the violet are also strong. All flames of hydrocarbons pre-mixed with air or oxygen show these bands, also a strong system of hydroxyl bands in the near ultra-violet and the hydrocarbon flame-bands, these systems all being easily seen in the spectrum of an ethylene - air flame. We thus find that many active radicals are present in the combustion zone, and this knowledge has had a marked effect on the development of chain-reaction mechanisms for combustion. Hydroxyl radicals, in particular, are used in very many schemes for the combustion, although the formation of C_2 and CH radicals is not usually accounted for by combustion theories, despite their prominence in the spectrum.

In flames at atmospheric pressure the reaction zone, represented by the inner cone of the ordinary Bunsen-type flame, is extremely thin. For the oxy-acetylene flame the luminous zone is only 1/50 mm. thick. Under these conditions, with thin conical flames surrounded by a relatively much greater thickness of hot burnt gases, it is not possible to study the structure of the reaction zone in detail. Dr. H. G. Wolfhard has, however, found that in flames at very low pressure the thickness of the reaction zone increases, roughly inversely as the gas pressure, so that at the lowest pressures it may be a few centimetres thick, and by adjustment of the pumping speed and gas flow it is possible to obtain flat disk-shaped flames. The experimental technique is simple; the essential thing is to use adequate pumping-speed and burners of very large diameter. Dr. Wolfhard and I, in collaboration, have examined the spectra of many flames at low pressure. Using a burner of 5½ cm. diameter, flames have been obtained down to 0·9 mm. of mercury pressure for oxy-acetylene—probably the lowest pressure at which a flame has so far been maintained.

These low-pressure flames of hydrocarbons are bluish and have a fairly marked greenish base, with a top that is more blue-violet. The spectrum shows C_2 bands extending towards the base, and CH predominating towards the top. One might expect that in breaking up a hydrocarbon molecule hydrogen atoms would be successively stripped off, with consequent formation of CH before C_2. However, the new observations suggest the reverse, that is, the formation of CH after C_2. A reaction such as $C_2 + OH = CO + CH$ may even be possible.

Empirical and qualitative spectroscopic studies of flames can thus give us a certain amount of useful information. However, we still do not know how some of the radicals found in flames are formed, nor do we know much about the peculiar excitation processes in flames. Astrophysicists have done excellent work on quantitative measurements of the spectra of stars, despite the small amount of light available, and have determined much about the composition, temperature and motion of stars. With a controllable laboratory source, the application of such methods should enable us to deduce much about what goes on in flames, even under the non-equilibrium conditions that prevail.

In the reaction zone, where the chemical energy is being released, we cannot expect equipartition of energy among its various possible forms, and it will not be possible to define the temperature of the flame. However, it is possible in some cases to determine the average amount of energy in a particular form and so to assign an effective temperature. The emission spectra only give information about the electronically excited molecules in the flame. For a molecule the energy may be divided between kinetic energy of translation, internal energy of vibration, rotation, and excitation of electrons from the lowest orbit to orbits of higher energy. Also, in the flame the proportion of molecules which are dissociated to free atoms may be used for estimating an effective temperature for this type of equilibrium. Attempts have been made to study the effective temperatures for the various possible forms that the energy may take for the excited radicals found in flames, in the hope that it may reveal the nature of the excitation processes.

In a band spectrum, the position of the system of bands is determined by the change of orbit of the electron, while the position of individual bands within the system depends on changes in vibrational energy. When examined with spectrographs of large dispersion, each band is found to consist of a large number of individual lines, these each corresponding to different changes in rotational energy. The intensity of a line, I, is given by

$$I = C.P.\nu^4.\exp(-E_r/kT),$$

where C is a constant depending on the exposure-time and strength of the flame, P the transition probability, ν the frequency of the spectrum line, E_r the rotational energy of the level from which the line arises, k the Boltzmann constant and T the absolute temperature. P, which depends on the rotational quantum numbers and the type of transitions, may be evaluated theoretically, and E_r is known from the analysis of the spectrum. Thus, if the relative intensities of two or more lines are compared, it is possible to evaluate T, the effective rotational temperature. This has been done for several molecules in various flames. An interesting example is hydroxyl.

In the oxy-hydrogen flame the emission of the hydroxyl band at 3064 A. is relatively weak compared with that from hydrocarbon flames. A striking effect is that of the addition of a little acetylene to an oxy-hydrogen flame. The addition of only 0·75 per cent reduces the exposure-time for comparable density from 2 hr. to 6 min., and it is obvious from the appearance of the plate that the rotational structure has extended considerably, corresponding to a higher effective temperature Actually, measurement on large dispersion shows that for the hydrogen flame the effective rotational temperature is approximately the expected flame temperature. In acetylene flames, the effective temperature is high and varies with pressure.

Pressure (mm. Hg.)	760	13	5·5	2·5	1·5
Effective rotational temperature (°K.)	5,400	5,700	6,200	7,000	8,750

These results may be explained by assuming that the hydroxyl radical is formed chemically in the electronically excited state, with high rotational energy as well. At very low pressure there is no collision deactivation, so that the observed temperature is very high. At high gas pressure there is collision deactivation, and then there is competition between loss of the electronic excitation (which can happen rather infrequently, but, when it does happen, it is of course complete) and loss of rotational excitation (which happens more readily, but probably only by a little at each collision) Approximate calculations indicate that on the average the excited hydroxyl radical survives about a hundred collisions before losing its electronic energy, and that during these hundred collisions the loss of rotational energy brings the effective temperature down to about 5,400° K. The formation of excited hydroxyl at high rotational energy requires a highly exothermic process. A possible reaction is $CH + O_2 = CO + OH$. If we assume a high value for the dissociation energy of carbon monoxide (the value of the dissociation energy is the subject of controversy), then this reaction would be sufficiently exothermic. It may be noted that all flames which show the high rotational temperature for hydroxyl also emit CH bands strongly.

Some progress has been made with measuring effective translational temperatures, thanks to a suggestion by Sir Alfred Egerton; this is by measuring the Doppler broadening of the spectrum lines. A Fabry–Perot interferometer is crossed with a large-dispersion spectrograph. Measurements are only reliable at low pressure because of pressure-broadening effects at high pressure. Also, self-absorption may cause trouble. For lines of lead and iron and perhaps for hydroxyl, the effective translational temperature appears to agree with the expected flame temperature. For lines of the CH bands, however, the effective translational temperature at low pressure is high, about 4,000° K.

Less progress has been made with vibrational temperatures, although some anomalies in vibrational intensity distribution have been noted. In oxy-hydrogen flames at low pressure, there appears to be selective excitation of hydroxyl to the $v' = 2$ level, that is, to a level with vibrational quantum number 2. This requires an energy of 108 kcal. per mole. The most likely reaction is

$$H + H + OH = H_2 + OH^*.$$

The reaction gives only 103 kcal., but the remainder may be accounted for as, perhaps, activation energy. A similar intensity anomaly has recently been observed in the CH bands, when organic compounds are added to the flame, by Mr. R. A. Durie, who has recently started work in my laboratory. These results support other indications that there is an excess of atomic hydrogen in hydrogen flames.

Effective electronic excitation temperatures may be determined by the spectrum line reversal method. Results are often very anomalous for pre-mixed flames of hydrocarbons. Thus, when lead is introduced into an oxy-acetylene flame at low pressure, the resonance line of lead at 2833 A. is reversed against the background of a carbon arc; it has a reversal temperature of about 3,300° K., about 600° above the flame temperature. The other lines, 2802 A., 2823 A., etc., however, show in emission against the carbon arc, and have brightness temperatures in excess of 4,500°. Some lead lines observed in emission require 150 kcal. per mole of excitation energy.

A recent important development is that of the design of a flat diffusion flame for spectroscopic study[1]. This type of flame is suitable for absorption spectra as well as for the study of emission. It may be stressed at this point that emission from diffusion flames appears to be mainly thermal in origin, in contrast with the emission from the inner cones of pre-mixed flames which show abnormally high excitation.

Another approach to the subject resembles that of chemical kinetics. The yield of light for various band systems may be studied in various flames and with various diluents, and some rather surprising results are being obtained. Thus, if in a flame of ethane and oxygen the ethane is progressively replaced with hydrogen in such a way as to keep the mixture stoichiometric, the flame temperature does not vary appreciably, and we might expect, on a naive approach, that the strength of the C_2 bands would fall off proportionally with the ethane concentration. Actually, it falls off much more rapidly, approximately as the cube of the ethane concentration. Present indications are that the formation of C_2 and CH in pre-mixed flames requires polymerization of the fuel.

So far, the spectra considered have all been band systems, indicating the presence of certain molecules in the flames. Flame spectra also contain a good deal of continuous emission. This continuum may arise from various causes, but it always indicates a process taking place rather than the mere presence of something. Processes of association and dissociation of molecules and of the formation and recombination of ions are responsible for the emission of continuous spectra. These are usually difficult to identify because of the characteristic lack of marked features. In the carbon monoxide flame the strong blue radiation has a mainly continuous spectrum, which is probably due to recombination of carbon monoxide and atomic oxygen.

The afterglow of air in a discharge tube is due to recombination of atomic oxygen with nitric oxide to form nitrogen dioxide. This yellow-green afterglow resembles the colour of the tip of some very hot flames; and I have identified this emission from flames with the $NO + O = NO_2$ reaction, and developed a test for the presence of atomic oxygen in a flame. On introduction of nitric oxide, some flames turn yellow-green. If, however, a hydrocarbon flame, such as an ethylene – air flame, is separated into its two cones in a Smithell's flame-separator, and nitric oxide is added to the fuel stream, then a marked yellow-green coloration may be seen in the outer cone, where carbon monoxide and hydrogen are burning, but not in the inner cone, where the initial break-up of the hydrocarbon occurs. From a detailed consideration of this, it can be shown that there is very little atomic oxygen present during the early stages of reaction, and this is evidence against combustion mechanisms requiring atomic oxygen.

While considerable advances have been made in the study of flame spectra during the past few years, we are still ignorant on many fundamental points. We do not know with certainty how C_2 and CH are formed, or the cause of the abnormal excitation in pre-mixed hydrocarbon flames. Quantitative measurements of the yield of light under various conditions, and detailed spectroscopic studies such as those of the astrophysical type, may be expected to give further information in the not very distant future.

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[1] Wolfhard, H. G., and Parker, W. G., *Proc. Phys. Soc*. A, 62, 722 (1949)

ENERGY EXCHANGE BETWEEN THE OCEANS AND THE ATMOSPHERE

PROGRESS in oceanographical research and its applications to marine physical and biological problems is likely to be slow until more is known about the natural processes which regulate the water movements in the oceans and the distribution of physical properties. Interaction between the atmosphere and the oceans is the most important of these processes, and particular attention is being paid to it in marine physical laboratories; the same information has useful applications to meteorology, and studies are being made of the vertical profiles of wind velocity, temperature and vapour pressure, close to the sea surface, and of the changes in heat and moisture content of air masses moving over the oceans. Recent progress formed the basis of a Geophysical Discussion held at the Royal Astronomical Society on October 28, at which Prof. P. A. Sheppard, of the Department of Meteorology, Imperial College of Science and Technology, and Mr. K. F. Bowden, of the Department of Oceanography, University of Liverpool, were the principal speakers.

The oceans gain most of their heat directly from the radiation of the sun, and it is estimated that they absorb nearly half the amount which reaches the outer limit of the atmosphere above them. The amounts received in different regions depend mainly on the latitude, time of year and the cloudiness of the sky. Since there is no appreciable change in the total heat content of the oceans, the gains must be balanced by losses, and it is known that heat is lost mainly by evaporation, by radiation to space, and to a lesser degree by conduction of heat from the water to the air. Regional heat balances are influenced to a considerable extent by the transfer of heat from one area to another by ocean currents.

The lower atmosphere gains most of its heat from the oceans; it is very transparent to direct radiation from the sun, and the difference between the amount of radiation reaching the upper limit of the atmosphere and that absorbed in the ocean is accounted for mainly by reflexion back to space from the atmosphere, clouds and water surface. The possible effect of absorption of short wave-length radiation in the very highest atmosphere is not known. Most of the heat is received from the condensation of water vapour, supplemented by direct conduction from the water. As in the oceans, there is no appreciable change in the total heat content from year to year, and the gains must be balanced by losses—chiefly by radiation to space. Numerical values have been given by various authors for the amounts of incoming and outgoing radiation in different latitudes and seasons, and also for the effect of reflexion from the sea, evaporation and conduction. They are all subject to revision; but they are sufficiently accurate to lead to reasonable conclusions when applied to the oceans as a whole, and to areas in which the changes from month to month in the heat content of the water are known.

Such information is not often available, and the transfer of heat from the sea to the air in a particular region is usually estimated from information about the vertical gradients of temperature and vapour pressure near the surface, and about the turbulent processes by which they diffuse upwards into the atmosphere. Complete data are never available, but by using a formula developed by H. U. Sverdrup[1] for evaporation at moderate and high wind-speeds, the routine observations, made by ships, of wind strength, sea temperature, and wet- and dry-bulb thermometer readings can be employed as a basis for the calculations. The amount of heat transferred by conduction can be calculated from the same figures, if it is assumed that the diffusion processes for temperature and water vapour are similar. W. C. Jacobs[2] has prepared maps of the heat losses from all parts of the North Atlantic and North Pacific Oceans for which long-period climatic data are available. The main features of the maps are areas of maximum heat-transfer where the Gulf Stream and Kuro Siwo current carry warm water northwards off the east coasts of the United States and Japan, the amount being much greater in winter than in summer. Both areas are regions in which violent storms originate.

Mr. K. F. Bowden[3] gave a brief description of his study (1948) of the heat transfer from the Irish Sea. Using assessments of incoming and outgoing radiation and measurements of the heat content of the water from month to month, he showed that the transfer of heat to the atmosphere is greatest in autumn and least in summer. He found some discrepancy between the heat transfer estimated by this method and that calculated from monthly figures for wind strength, sea and air temperatures, and relative humidity. In the discussion that followed, Prof. M. Neiburger (University of California) mentioned recent observations which suggest that there must be some revision of previous estimates of the effect of cloud. Mr. Bowden mentioned that there is some uncertainty about the formula for evaporation: some workers hold that the amount is practically independent of the state of the surface, while others suggest that it is four times as great for a rough as for a smooth surface. Other speakers remarked that discrepancies could result from the difficulty of making observations sufficiently close to the surface. Attention was directed to evidence that in calm and moderate weather there can be a thin film of water at the surface in which the temperature differs significantly from that measured by dipping a bucket. Mr. J. Francis argued that greater use should be made of laboratory models.

Several speakers emphasized the need for further study of the diffusion processes near the sea surface with simultaneous observations in air and water, the behaviour of one being inexplicable without due regard to the other. Some disappointment was expressed that the state of knowledge and time available did not allow more to be said about the transfer of kinetic energy from the atmosphere to the sea; it was felt that there is a danger of under-estimating the proportion of the heat content of the atmosphere which is turned into mechanical energy, and of the fraction of this mechanical energy which is transferred to the oceans to contribute to the growth of waves, temporary wind drifts and permanent ocean currents. With reference to such transfer, Mr. H. Charnock showed that if data from every available source are plotted, the break between 'smooth' and 'rough' surfaces described by W. H. Munk[4] is not proved, though some of the other evidence, such as the abrupt change in the flight of seagulls at wind speeds of about 7 metres a second (15½ m.p.h.), is more convincing. Mr. L. Verra, referring to preliminary results of measurements made to determine the tangential wind stress from the changes in slope of the surface of Lough Neagh, said that, although the observations show considerable scatter, they are in general agreement with the assumption that the stress is proportional to the square of the wind velocity for all wind strengths up to 20 knots. Using this assumption, the mean stress coefficient is 0·0013, which is approximately the mean of all the other values that are available. If the observations are grouped according to air temperatures, there is evidence that the stress is greater when the air is unstable.

Prof. P. A. Sheppard gave some indication of how the calculation of heat transfer from the sea would be useful in meteorology and climatology. Mr. J. Craddock, of the Forecasting Research Division, Meteorological Office, quoted a heat transport of 600 cal./cm.^{2}/day from sea to air measured by observations at twenty-five points in the path of a particular air mass. This was understood to be in agreement with Jacobs's calculations for the North Atlantic Ocean in winter. Interaction with the oceans is only part of the meteorological problem; but the ocean surfaces are four times as extensive as the land, and some of the processes which require investigation may be simpler owing to the absence of topographical effects. The heat transfer is only part of the oceanographical problem, since the permanent ocean currents seem to derive most of their energy from the mechanical stress of the wind on the sea surface. Such a current may play an important part in determining the amount of energy which is available for transfer to the atmosphere in a particular region, and every change in the prevailing wind will lead to a change in the current which must again affect the atmosphere. The details of the interaction between the oceans and atmosphere have still to be worked out, and there is no doubt that their investigation offers great scope.

G. E. R. DEACON

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[1] Sverdrup, H. U., *J. Marine Research*, 1, 3 (1937).

[2] Jacobs, W. C., *J. Marine Research*, 5, 37 (1942).

[3] Bowden, K. F., *Mon. Not. Roy. Astro. Soc., Geophys. Supp.*, 5, 270 (1948).

[4] Munk, W. H., *J. Marine Research*, 6, 203 (1947).

OPENING OF THE NATIONAL CHEMICAL LABORATORY OF INDIA

THE Council of Scientific and Industrial Research of India planned eleven national laboratories. The seventh of these, the National Chemical Laboratory, is nearing completion and was officially opened by the Prime Minister of India, Pandit Nehru, on January 3. A description of the preliminary plans was given in *Nature* of February 15, 1947.

Begun in April 1947, the building, of Western design and magnificent proportions, makes an impressive picture set in a natural amphitheatre of hills about four miles from Poona. It is well equipped for scientific research in chemistry in both pure and applied fields, and when completely staffed will operate through nine departments; namely, organic chemistry, biochemistry, chemical engineering, plastics and high polymers, survey and information, inorganic chemistry, physical chemistry, administration and standardization of chemicals, development of bhilawan and cashew products. It will thus provide the possibility of effective co-operation between scientific research and industrial production —a co-operation which is essential to sound economy.

The important problem of collecting the right personnel for staffing is gradually being solved by the director, Prof. J. W. McBain, whose unceasing labour since his arrival in October 1949 is largely responsible for the advanced stage which the Laboratory has already reached. Several of the nine departments are already operating, and about seventy-six of the staff, which will ultimately number some one hundred and fifty scientific men, are appointed.

In his opening speech, Pandit Nehru stressed the importance of "personnel, which provides the essential spirit of an institution. It is more important than the buildings themselves, necessary and splendid though they are". He pointed out that "India has the people and the talent. The problem is to tap that talent. Money itself cannot be produced without people, and a country which is rich in talented people must therefore possess a potential source of wealth. People can make money, but money cannot make people. But it is not sufficient to make money alone, it is also necessary to concentrate on scientific advancement." He was surprised at the amazing ignorance of the importance of science to industry among industrial leaders. On the other hand, it might be said with justification that the Government had, during the past two years, done something in the matter of science and scientific research—it had at least laid the foundations of future work.

After the opening, Prof. McBain, addressing the large and distinguished audience, dedicated himself and the whole of the personnel to the service of the people of India and invited their co-operation, stressing its importance. He went on to speak of the ethical and spiritual qualities necessary for the pursuit of science. Science is in no way at variance with the highest spiritual and ethical aims, but must of necessity be integrated with them. Thus, devotion to truth, no matter how unwelcome or what personal self-sacrifice it involves, is, above all else, essential. Loyalty is also a requisite—loyalty both to the work undertaken and to humanity as a whole. Only those whose characters include such attributes are in a position to render any worthwhile service; but such true service, however small, is eternal in the mind of God.

The proceedings were presided over by His Excellency the Governor of Bombay. Others who took part were the Honourable Dr. Syama Prasad Mookerjee, Minister of Industry and Supply, and vice-president of the Council of Scientific and Industrial Research; Sir Shanti Bhatnagar, director of scientific and industrial research; and four Nobel laureates, Sir Robert Robinson, Dr. A. H. Compton, Madame Joliot-Curie and Sir C. V. Raman.

After the opening, the Laboratory was inspected by Pandit Nehru, attended by the Director; and a large number of scientific workers, including many from overseas, toured the building and saw the numerous exhibits set up in the various laboratories already operating. About five thousand people attended the colourful ceremony.

OBITUARIES

Dr. Isaiah Bowman

The sudden death of Dr. Isaiah Bowman at Baltimore on January 6, eleven days after his seventy-first birthday, has robbed the world of its premier geographer and the United States in particular of an elder statesman in the true sense of the word, whose wise counsels had for forty years been at the disposal of successive Presidents.

By birth a Canadian, his childhood and schooldays were spent in Ontario, and it was to secure better training as a teacher that he went to Ypsilanti in Michigan in the United States, which was henceforth to be his adopted country. From Ypsilanti he went on to take a degree in science at Harvard, and after one year back at Ypsilanti he returned to Harvard as assistant professor of physiography. The following year, 1905, when he was twenty-six, he joined the Department of Geography at Yale, where he remained for ten years. His work there serves as a model for all young geographers. He combined a thorough study of his own continental area with pioneer exploration in South America. He was a leader in 1907 of an expedition to the Andes of South America promoted by Yale University, and in later years took part in many other exploratory journeys in that continent. As a result of his home studies, there appeared in 1911 the volume entitled "Forest Physiography". The contents of this book to some extent belie its title. It is, in fact, a very thorough study of the physiographical conditions in the United States as they influence the natural vegetation cover, and so provide the essential environments for human settlement. His journeys in South America resulted in a series of scholarly monographs, culminating in his book, "The Desert Trails of Atacama", issued as a special publication by the American Geographical Society in 1924.

In the meantime, after leading the American Geographical Society's expedition to the Central Andes in 1913, he had been appointed director of the American Geographical Society in New York, a post which he held for twenty years, from 1915 until 1935.

During the First World War, the American Government found in Dr. Bowman the ideal man to collect vital geographical information on an immense range of topics, and it was natural that he should play a major part in the Versailles Peace Conference. Few universities in Britain, or indeed in many other countries in the world, had at that time either undergraduate or advanced courses in geography. This fact was reflected in the inadequate factual knowledge at the disposal of many of the delegations to the Conference. In contrast, the American delegation showed itself amazingly conversant with the intricacies of European political geography. It is enormously to Dr. Bowman's further credit that he quickly gave to the world after the Peace Conference his book "The New World", which has run through many editions and which described with utmost lucidity the political geography so largely determined by the post-war settlement.

From that time onwards, Dr. Bowman remained in closest touch with successive Presidents of the United States. With his guidance, the American Geographical Society became the focus of much important research; under its auspices came the stream of 1:1,000,000 maps of South America. Dr. Bowman himself turned his attention to the problems of the development of marginal lands. His book in this field, "The Pioneer Fringe", is one which we should all do well to study at the present day, in that it shows the difficulties met by pioneers both in the past and at present, and how frequently adverse natural conditions have succeeded in driving back the over-bold, a fact which is being forgotten by those who talk at present too eagerly of the development of tropical lands.

In 1935, Dr. Bowman became president of Johns Hopkins University, from which he retired only shortly before his death on reaching the age of seventy. Again his clarity of vision saw a way of overcoming one of the major difficulties before the universities of to-day, where the professor or head of the department is so often swamped by routine duties resulting from immense numbers of students. He established at Johns Hopkins University a Department of Geography under the chairmanship of a young, energetic geographer, leaving such senior teachers as Owen Latimore and R. L. Pendleton free to pursue their own researches. The School was designed for a relatively small number of carefully selected students; but the principle of appointing a relatively young head of department to shoulder administrative responsibility is one that has since been copied with advantage elsewhere.

During the Second World War, Dr. Bowman's immense range of knowledge was once more in constant demand. On several occasions he had such delicate missions as conveying personal messages from President Roosevelt to Mr. Churchill, and it is not too much to say that he was an important architect of both the League of Nations and the United Nations Organisation.

Honours from many universities and learned societies included an honorary degree from Yale in 1921, the Livingstone Medal of the Royal Scottish Geographical Society in 1928, the Patron's Medal of the Royal Geographical Society in 1941, and an honorary D.C.L. of the University of Oxford in 1944.

Dr. Bowman was a man of great personal charm. To many of the young geographers, like the present writer, he was not only a readily accessible counsellor, but also a very real friend. He had a flair for almost instantaneous appreciation of good or promising work. He was very practical in his outlook. He found philosophical discussion on the delimitations of fields of study arid and irksome; but he was immensely alive to the possibilities of the application of geographical methods to world problems, as shown by his "Geography in Relation to the Social Sciences" (1934). Only three weeks before his death, when the Commission appointed by the International Geographical Union had drawn up at Worcester, Mass., its scheme for a Land Use Survey of the World, the main proposals were read over the telephone to Dr. Bowman at his home, and in the course of half an hour's conversation he not only gave his blessing to the scheme and his promise to further the objective, but also made many valuable comments on detail. The loss of such a vigorous mind and a great world figure is a world tragedy. L. Dudley Stamp

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We regret to announce the death of Prof. Richard Fosse, a former occupant of the chair of chemistry applied to organisms in the Natural History Museum, Paris, and member of the Section of Rural Economy and Veterinary Practice of the Paris Academy of Sciences, on December 18, 1949, aged seventy-nine.

NEWS and VIEWS

Anthropology at Cambridge:
Prof. J. H. Hutton, C.I.E.

Prof. J. H. Hutton is to retire this year from the William Wyse chair of social anthropology at Cambridge which he has held since 1937. Prof. Hutton entered the Indian Civil Service in 1909. Posted first to Eastern Bengal, he was transferred to Assam in 1912 and served for the next seventeen years in the Naga Hills. Up to that time little or no anthropological work had been done on the tribes in the Naga Hills district, and Hutton soon set himself to remedy this deficiency, first in the interests of administration and later in those of science. The First World War kept him in the Naga Hills but prevented the publication of any considerable work until 1922, when he published both the "Angami Nagas", which had been finished much earlier, and the "Sema Nagas". Meanwhile, in addition to his administrative duties as deputy commissioner of the Naga Hills, he had been appointed honorary director of ethnography for Assam, and in virtue of that office promoted the publication of a number of other tribal monographs by his colleagues, on the Naga and Kuki-Lushei tribes. For his work as political officer in the Kuki Punitive Operation of 1917–19 he was awarded the C.I.E. He left Assam in 1929 to undertake responsibility for the India Census of 1931, and for four years Delhi and Simla were his headquarters. This task enabled him to become acquainted with many of the remoter parts of the Indian Empire. In addition to the two volumes already mentioned and his "Report on the Census of India, 1931", he published grammars of the Sema and Chang-Naga languages, previously not reduced to writing, and two or three readers for elementary schools in those vernaculars. His "Caste in India" was published in Cambridge in 1948. His honours have included the Rivers Memorial Medal of the Royal Anthropological Institute in 1929, the Silver Medal of the Royal Society of Arts in 1932, and the Annandale Memorial Gold Medal of the Asiatic Society of Bengal in 1937. He was Frazer Lecturer in Oxford in 1938. Prof. Hutton has done much to consolidate the Cambridge school of archæology and anthropology, where he has admirably held the balance between the various subjects taught, and has proved an excellent chairman of the Faculty Board. During the War, he carried most of the burden of the anthropological teaching on his own shoulders.

Dr. M. Fortes

Dr. Meyer Fortes, who will succeed Prof. Hutton, was born in 1906, educated at the South African College High School and the University of Cape Town, and is a Ph.D. of London, where his postgraduate degree was taken in psychology under the late Prof. C. Spearman in 1930. Working as a research assistant to the late Prof. Seligman, he turned from psychology to anthropology in 1932 and continued to study under Malinowski as a Rockefeller fellow. During 1934–37 he worked in the Northern Territories of the Gold Coast, and on return from the field was appointed lecturer in social anthropology at the London School of Economics in 1938. The following year he was appointed research lecturer in African sociology at Oxford. In 1941 he undertook a field survey of Nigeria on behalf of the Nuffield Colonial Research Scheme, and after this was engaged on national service until appointed head of the Sociological Department of the West African Institute, Gold Coast, and director of the Ashanti Social Survey, in 1945. In 1946 he was appointed reader in social anthropology at Oxford. He holds the Wellcome Gold Medal of the Royal Anthropological Institute (1937) and its Rivers Memorial Medal (1947). His two most important published works are "The Dynamics of Clanship among the Tallensi" (1945) and "The Web of Kinship among the Tallensi" (1949); and he is the editor of the *Journal of the Royal Anthropological Institute*.

Higher Technical Education in the Colonies

Mr. Arthur Creech Jones, Secretary of State for the Colonies, has set up a committee to advise him on the development of Colonial colleges of arts, science and technology (hitherto referred to provisionally as 'regional colleges'). The committee's provisional terms of reference are as follows: "To advise the Secretary of State and any responsible authorities in the Colonies on the development of Colonial Colleges of Arts, Science and Technology and to advise on expenditure of Colonial Development and Welfare funds allocated for this purpose". The committee is as follows: Dr. Keith A. H. Murray (chairman), rector of Lincoln College, Oxford; Mr. T. H. Baldwin, formerly deputy director of education, Nigeria, now assistant educational adviser to the Secretary of State for the Colonies; Mr. H. T. Bourdillon, head of Finance Department, Colonial Office; Sir Christopher Cox, educational adviser to the Secretary of State; Sir James Duff, pro-vice-chancellor, University of Durham; Sir William Hamilton Fyfe, formerly vice-chancellor and principal, University of Aberdeen; Dr. F. J. Harlow, formerly principal, Chelsea Polytechnic; Mr. R. J. Harvey, formerly director of education, Zanzibar, now in the Colonial Office; Mr. J. C. Jones, principal, Regent Street Polytechnic; Prof. Margaret Read, professor of education with special reference to education in the Colonies, and head of the Colonial Department, University of London Institute of Education; Mr. J. J. Robertson, rector, Aberdeen Grammar School; Dr. J. E. Richardson, principal, Northampton Polytechnic, London; Mr. H. C. Shearman, academic adviser for tutorial classes, University of London, vice-president and formerly education officer, Workers' Educational Association; Dr. Cameron Smail, principal, Heriot-Watt College, Edinburgh; Rev. R. W. Stopford, secretary of council and moderator of Church Training Colleges, formerly principal of Achimota College, Gold Coast; Mr. W. Adams (observer), secretary to the Inter-University Council for Higher Education in the Colonies, and Mr. H. M. Collins, Colonial Office (secretary).

Initially, the committee will be concerned primarily with West Africa. It is hoped that two new colleges will be established in the immediate future: one serving the Gold Coast, at Kumasi, and the other, in Nigeria, is likely to be a tripartite organisation with branches in each of the territory's three regions. These colleges will be complementary to the existing university colleges. It will be their aim to provide courses of higher technical and commercial education of whatever type may seem best suited to the needs of each territory; also courses for the training of teachers and social welfare and community development workers. In addition, they will participate in schemes of adult education, and, pending further developments in secondary education, will provide general education at higher certificate level. They will become centres for cultural and technological development, for refresher courses, and for the encouragement of the arts and crafts. Generally, they are designed to be readily adaptable to meet the varying needs of the territories they serve. Although the reconstituted Fourah Bay College in Sierra Leone will differ in many respects from the new colleges in Nigeria and the Gold Coast, more particularly in that it will retain and develop its University Department, the committee will be ready to advise and assist it. In addition to offering advice on general development and the allocation of United Kingdom funds available for these Colleges under the terms of the Colonial Development and Welfare Act, 1945, the committee will also be responsible for advising on the selection of staff.

Festival of Britain, 1951

In connexion with the Festival of Britain, to be held during May–September 1951, it has been recently announced that the display of British achievements in science and technology will be centred on four projects: South Bank Exhibition, London; Travelling Exhibitions; 1951 Exhibition of Science, Science Museum, South Kensington, London; 1951 Exhibition of Industrial Power, Kelvin Hall, Glasgow. Details of the South Bank Exhibition have already been given (see *Nature*, December 24, 1949, p. 1083), and the two Travelling Exhibitions, which will be on the lines of that on the South Bank, will tour Great Britain by land and by sea: the latter will be fitted up in the escort carrier *Campania*. The theme for the South Kensington Exhibition is limited to the growth of the understanding of the nature and architecture of matter. The sequence will proceed from the study of matter (physical, chemical and biological) on a macroscopic scale down through the orders of magnitude to atomic and nuclear particles. This Exhibition is designed primarily for those who, though not necessarily trained in any specific science, have a general leaning towards things of scientific interest. Engineering machinery and the part it has played in shaping the British citizen's daily life will be shown at the Glasgow Exhibition, where the two principal topics will be coal and water. The former will cover mining, iron and steel, machine tools, power units, electric power generation and transmission, railways and shipbuilding; the latter will consider hydro-electricity, civil engineering and irrigation. The two themes will be integrated in the final section, which is on the future use of nuclear energy for industrial power.

Systemic Insecticides and Swollen Shoot Disease of Cacao

The director of the West African Cacao Research Institute, Tafo, Gold Coast, has arranged for a team of three men of science from Messrs. Pest Control, Ltd., Bourn, Cambridge, to work at the Institute on an investigation of the possible use of systemic insecticides to control the spread of swollen shoot disease of cacao in West Africa. The object of these experiments is, of course, not to kill the virus of swollen shoot disease but to kill the mealybug which is the vector of the disease. Thus, the most that the discovery of an effective systemic insecticide could achieve would be to prevent or reduce the spread of infection from trees infected with swollen shoot to healthy trees, and three or four years at least must elapse before any conclusion, positive or negative, can be reached. There is no known cure for a plant disease virus once it is established in a tree or plant, and the only way to kill the virus is to destroy the tree or plant itself. Cutting-out of diseased trees must, therefore, always remain an essential and fundamental part of any successful campaign to rid the cocoa-growing areas of West Africa of the scourge of swollen shoot disease (see *Nature*, 163, 15 and 271; 1949).

Physics Today: Costs of Production

It is announced in the editorial of the October issue of *Physics Today* that, beginning in January 1950, the free distribution of that monthly periodical to members of the American Institute of Physics will cease. The annual subscription will be 4 dollars for members of the Institute and 5 dollars for non-members. It had been hoped that *Physics Today*, which has appeared regularly for some twenty months (see *Nature*, 162, 988; 1948), would by 1951 be self-supporting; but it is now clear that, because of the increase in the number of members of the Institute, the rise in the cost of printing and the rather slow increase in the number of advertisers and subscribers, this cannot be achieved. It will be remembered that *Physics Today* is a general-interest journal on physics, a non-technical magazine limited to one science, but "in which physics and the things about it are put in a language which others can use for better understanding". There is a definite need for a medium through which news and discussion of what is going on in physics can be made known to physicists in general, to men of science working in other fields than physics and to the general public. *Physics Today* has so far admirably fulfilled this need, and it is to be hoped that it will continue to receive adequate support in spite of the increased cost to subscribers.

Infra-red Discussion Group

A meeting of people engaged on, or interested in, infra-red spectroscopy was held in the Royal Technical College, Glasgow, on January 20, in order to consider the formation of a discussion group on mutual problems and interests. It was decided to form an informal body to be called the Infra-red Discussion Group. Dr. A. E. Martin (Sir Howard Grubb, Parsons and Co.) was elected chairman, and Mr. K. S. Tetlow (Imperial Chemical Industries, Ltd., Nobel Division, Stevenston, Ayrshire) secretary. Membership (no fee) is open to persons, firms and organisations willing to co-operate, when possible, in the activities of the Group. The first meeting considered comparative extinction coefficient measurements, the reporting of spectra, definitions and instrumental matters.

Frank Knox Memorial Foundation Fellowship

A fellowship, worth 2,400 dollars, of the Frank Knox Memorial Foundation is being offered for a male student from the United Kingdom to spend the academic year 1950–51 at Harvard University. The fellowship is open to students of all stages, preference being given to graduates or those about to graduate, and a major part of the year must be spent studying in one of the faculties at Harvard. Applications (by letter on quarto paper, five copies) should include full particulars of past career and prospective course of study, together with a testimonial of the candidate's supervisor and the name of a referee. Such applications should be forwarded, not later than April 1, through the head of the applicant's university or college to the Secretary, Association of the Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1, from whom further particulars can be obtained.

Colonial Service: Recent Appointments

THE following appointments in the Colonial Service have been recently announced: L. J. Foster, agricultural officer (horticulture), Nyasaland; N. Lamont, agricultural officer, Fiji; T. O. Robson, pasture research officer, Tanganyika (seconded to Kenya); R. J. Spooner, agricultural officer, Kenya; S. K. Reakes-Williams, agricultural officer, Tanganyika; W. J. Harrison, J. S. Lightbody and H. Searle, assistant conservators of forests, Nigeria; J. A. Goodlet, assistant conservator of forests, Trinidad; J. G. Lumsden, assistant conservator of forests, Northern Rhodesia; J. D. Todd, assistant conservator of forests, Mauritius; D. C. Jones, geologist, Nigeria; E. R. Pollard, geologist, British Guiana; D. F. Hamilton and J. G. Ross, veterinary officers, Cyprus; J. D. Rennie, veterinary officer, Nyasaland; M. M. Scott, veterinary officer, Northern Rhodesia; D. G. Bouring, agricultural cocoa survey officer, Gold Coast; D. P. Braithwaite, biochemist, Veterinary Department, Kenya; C. A. Ellis and J. Longden, assistant statisticians, Nigeria; R. S. Hall, statistician, East Africa High Commission; P. A. Towsey, statistician, East Africa Statistical Department, East Africa High Commission; D. R. Niven, fisheries officer, Federation of Malaya; A. McDonald, meteorologist, Federation of Malaya; W. H. Whitely, anthropologist, Tanganyika; C. E. J. Biggs (deputy director of agriculture, Tanganyika), director of agriculture, Tanganyika; G. B. Gregory (agricultural superintendent, Grenada), senior agricultural officer, British Honduras; G. W. Lines (principal agricultural officer, Sierra Leone), deputy director of agriculture, Sierra Leone; H. MacLuskie (senior agricultural officer, Sierra Leone), station agricultural officer, Rice Research Station, Sierra Leone; B. J. Silk (agricultural officer, Gold Coast), agricultural education officer, Gold Coast; J. R. P. Soper (senior agricultural officer, Federation of Malaya), deputy director of agriculture, Tanganyika; S. G. Wilson (senior veterinary research officer, Uganda), chief field zoologist, Kenya; Miss F. M. L. Sheffield (specialist officer, Clove Research Scheme, Zanzibar), cytologist, East African Agriculture and Forestry Research Organisation; N. Yenli (assistant agricultural officer, Gold Coast), agricultural education officer, Gold Coast.

Exhibition in London of French Scientific Instruments

IN connexion with this Exhibition at the Science Museum, London, S.W.7 (see *Nature*, January 14, p. 59), the following lectures have been announced: February 8, at 4.15 p.m., Prof. E. Bauer, on "Scientific Research in France"; and H. Volkringer, on "The Centre National de la Recherche Scientifique, and the Commission des Inventions" (admission by tickets obtainable from the Scientific Office, French Embassy, 58 Knightsbridge, London, S.W.1). February 9, at 6 p.m. (at the French Institute, Queensberry Place, London, S.W.7), Prof. E. Bauer, on "Philosophie de la mesure et de l'observation en physique". February 10, at 4.30 p.m., Dr. J. Guéron, on "Some Methods and Instruments used at the Commissariat à l'Energie Atomique", and L. Couffignal, on "The Calculating Machine of the Institut Blaise Pascal". February 14, at 4.30 p.m., P. Le Rolland, on "Pendulum Methods for the Study of the Elastic Properties of Solids". February 16, at 4.30 p.m., P. de Fonbrune, on "Some New Methods of Micro-manipulation". February 21, at 4.30 p.m., M. Chevenard, on "Some French Apparatus for Use in Metallographic Research" (lecture to be read by Dr. L. Haughton); and Ingénieur Général C. R. Libessart, on "The Kinetics of Carbon Reactions". February 24, at 4.30 p.m., Dr. L. Kowarski, on "Atomic Energy Developments in France: 1946–1950". Except where stated, the lectures will be given in the Lecture Theatre of the Science Museum, and with the exception of those on February 8, are open to the public without tickets.

Announcements

PROF. J. B. ELIAS MELIN, professor in the Institute of Physiological Botany, University of Uppsala, has been elected *Correspondant* for the Section of Botany of the Paris Academy of Sciences in succession to the late M. Emmanuel Teodoresco.

THE Liverpool University Chemical Society Medal for 1950 has been awarded to Dr. W. H. Garrett, a graduate of the University and a director of Monsanto Chemicals, Ltd., for services to chemistry in the industrial field. The Medal will be presented at the annual open meeting of the Society on February 23 at 4.30 p.m., when Dr. Garrett will deliver a lecture entitled "The Need for Flexibility in University–Industry Relations".

THE Council of the Institute of Fuel announces that Mr. J. F. Ronca, at present honorary secretary of the Institute, will succeed Dr. D. T. A. Townend as president in October 1950. The Melchett Medal for 1950 has been awarded to Prof. R. J. Sarjant, professor of fuel technology in the University of Sheffield.

DR. J. PEARSON, head of the Chemistry Section of the British Iron and Steel Research Association Laboratories at Sketty Hall, Swansea, since 1946, has been appointed head of the Chemistry Department of the Association in succession to Dr. F. D. Richardson. Dr. Pearson is a graduate of the University of London, and was awarded the degree of Ph.D. in 1940 for research on the polarography of nitro-compounds. In his new post, he will be responsible for research on the physical chemistry of iron and steel making, refractories and problems of corrosion.

A David Anderson-Berry Silver-Gilt Medal, with a sum of about £100, will be awarded during 1950 by the Royal Society of Edinburgh for work on the therapeutical effect of X-rays on human diseases. Applications (with copies of relevant papers on accomplished work) must be sent to the General Secretary, Royal Society of Edinburgh, 22 George Street, Edinburgh 2, by March 31, 1950.

ERRATUM. Dr. W. Boas and Mr. P. J. Fensham state that in their communication entitled "Rate of Self-Diffusion in Tin Crystals" in *Nature* of December 31, 1949, p. 1127, they have discovered an arithmetical error in the computation of the constant A parallel to the c-axis, which appeared in Table 2 as $8{\cdot}4 \pm 3 \times 10^{-4}$. This should read $1{\cdot}2 \pm 0{\cdot}45 \times 10^{-5}$. The ratio A_c/A_a should therefore be $\sim 10^3$, not $\sim 10^4$ as stated. This alteration, however, leaves the conclusions quite unaffected.

CARBON DIOXIDE AND THE EXTENSION GROWTH OF ETIOLATED OAT SEEDLINGS

By C. L. MER and F. J. RICHARDS
Research Institute of Plant Physiology, Imperial College of Science and Technology, London. S.W.7

THE possibility of carbon dioxide entering metabolic cycles in higher plants in the absence of light may no longer be disregarded in view of the discovery of its assimilation by bacteria[1] and of recent work on the first stage of photosynthesis[2,3]. Heath[4] has further demonstrated that change in carbon dioxide concentration below that normally found in air is an active factor controlling stomatal movement.

In the course of an investigation on the effects of illuminating etiolated oat (*Avena*) seedlings, a further effect has been noted, namely, stimulation of extension growth of the mesocotyl, and depression of growth of the coleoptile.

The plants were grown under litre beakers lined with damp blotting paper to maintain a humid atmosphere, in cylindrical tin containers some 6 in. in diameter and 7 in. tall, provided with closely fitting lids to exclude light. It was found that the mesocotyls of such seedlings when seven days old varied considerably among the replicate tins; in some cases the average length was approximately 70 mm., while in others it was more than 80 mm., and this difference was significant at the 1 per cent level. Columns 1 and 2 in Table 1 show the measurements in mm. obtained on two successive occasions with containers *A* and *B* selected to show the differences.

There was no disparity in the size of the tins, and in view of the known effect of light in reducing the length of the mesocotyl, both were tested for light leaks by placing photographic paper in them. The paper was found to remain unaffected. The only difference observed was that the lid of *B* fitted tightly while that of the other was looser, and the possibility emerged that differences in gaseous exchange due to this cause may have been responsible for the variability noted.

The first test, therefore, was to bind the junction of the lid and body in both cases with gummed paper tape; the measurements of the plants after a seven-day growing period under these conditions are shown in column 3. The mesocotyls were now comparable in length, owing to *increased* growth within tin *A*.

A quantity of 10 *M* potassium hydroxide was next included in container *B* (which formerly produced the longer mesocotyls), the other acting as control; the lid junction in both cases was sealed with 'Plasticine', which was more satisfactory than the gummed paper previously used. The plants were again measured when seven days old; the lengths are recorded in column 4, and it will be seen that the absence of potassium hydroxide resulted in a marked increase in the length of the mesocotyl. To ensure that this was not fortuitous, potassium hydroxide was later included in container *A*, *B* acting as control. The results (column 5) show the same effect but in the other tin.

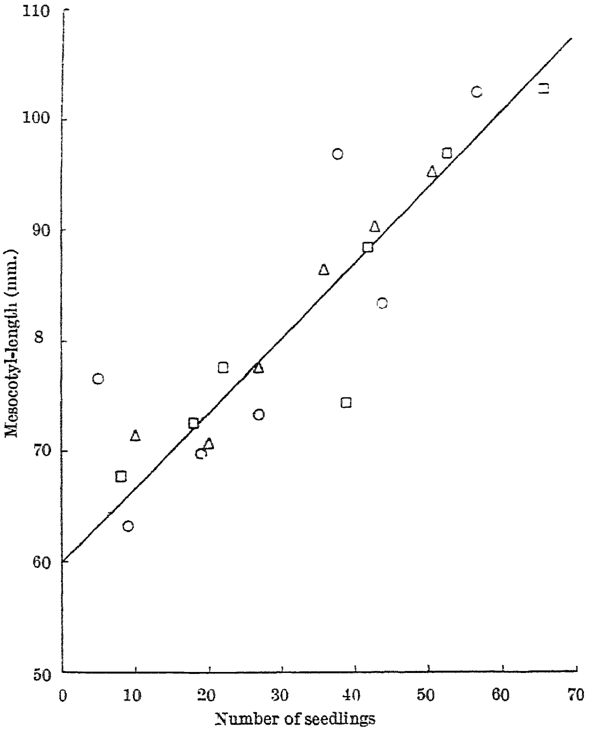

Fig. 1. ○—○—, Expt. 1; □—□—, expt. 2; △—△—, expt. 3

It was suspected that part of the effect of the presence of potassium hydroxide might have been due to the reduction in the humidity within the tin, which of necessity resulted from its use; but this was disposed of by including in the control tin a suitable solution of calcium chloride previously exposed for twenty-four hours to a 20 per cent carbon dioxide in air mixture to prevent the loss of the carbon dioxide produced by respiration of the plants by solution in the calcium chloride. This, consequently, would maintain the carbon dioxide content in the tin, and simultaneously reduce the humidity to a level comparable with that resulting from the use of potassium hydroxide.

Table 1

		1	2	3	4	5
A	No. of plants	52	43	48	48	47
	Mesocotyl-length	76·9 ± 0·98	75·7 ± 1·26	86·2 ± 1·15	104·3 ± 1·79	72·1 ± 1·21
	Coleoptile-length	43·7 ± 1·85	39·7 ± 2·1	22·6 ± 0·78	44·9 ± 1·67	49·8 ± 1·37
B	No. of plants	51	42	49	49	49
	Mesocotyl-length	85·7 ± 1·43	83·8 ± 1·36	84·6 ± 1·07	76·8 ± 0·84	104·5 ± 1·47
	Coleoptile-length	41·8 ± 1·73	43·2 ± 1·89	20·8 ± 0·9	51·9 ± 1·48	52·8 ± 1·22

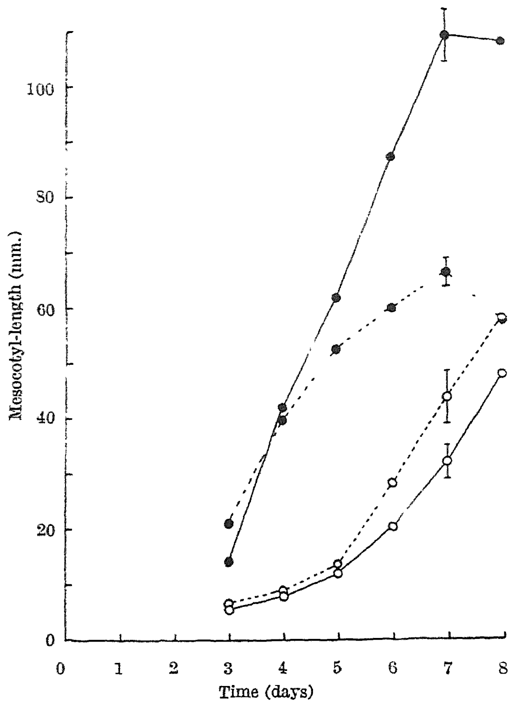

Fig. 2. ●—●—, 5% CO_2 } mesocotyls; ●..●.., control; ○—○—, 5% CO_2 } coleoptiles; ○..○.., control

The mesocotyls were again longer when grown in an atmosphere containing carbon dioxide; the lengths of two sets were: in the presence of potassium hydroxide 72·4 ± 0·88 and 68·7 ± 1·16 mm., in the presence of calcium chloride 101·4 ± 1·45 and 100·4 ± 1·21 mm.

In a further experiment plants were grown in a graded series of carbon dioxide concentrations to find if there were a corresponding gradation in mesocotyl-length. This was arranged by planting a different number of seeds in each of several tins: 5, 10, 20, 30, 40, 50, 60, respectively. The tins were then sealed with 'Plasticine' as previously. The results of three such experiments are shown in Fig. 1, in which mesocotyl-length at seven days, in mm., is plotted against the number of seedlings which germinated and grew in each of the tins. It is evident that there is a relationship between these two variables, and, combining all the results, the calculated regression line is $y = 59{\cdot}9 + 0{\cdot}67\,x$, where y is mesocotyl-length and x the number of seedlings. As the standard error of the second term (0·67) is 0·028 there can be no question that final mesocotyl-length is a function of the number of seedlings present, and presumably of the concentration of carbon dioxide in the tin.

Table 2

	Controls	1% CO_2	Controls	5% CO_2
No. of plants	47	47	51	47
Mesocotyl-length	56·5 ± 0·96	54·6 ± 0·97	56·0 ± 0·73	95·7 ± 1·21
Coleoptile-length	57·1 ± 0·77	55·0 ± 0·74	50·3 ± 1·17	29·5 ± 0·8

While these experiments were in progress, the necessary apparatus for growing plants in continuously flowing gas streams saturated with water vapour was assembled. A preliminary trial using 1 per cent carbon dioxide in air showed that this had no appreciable stimulatory effect, but a second with 5 per cent carbon dioxide was successful (Table 2).

Fig. 2 shows the result of an experiment using 5 per cent carbon dioxide, with air as control, in which sufficient plants were grown to take daily samples (which were discarded after measurement) from the third to the eighth day, and it is evident that there is a stimulating effect on the mesocotyl and the reverse on the coleoptile. The vertical lines shown on the seventh-day sample indicate the fiducial limits of variation of the means at $P = 0{\cdot}01$.

The reduction of coleoptilar extension found in the gas stream experiments was not consistently noted in previous experiments with sealed tins, this being probably due to the fact that, in the latter, carbon dioxide concentration was only gradually built up to the effective level, whereas in the former a high concentration was present from the beginning.

An interesting conclusion may be drawn from the regression equation; for when x (the number of seedlings in the tin) approaches zero and there is then no stimulating effect, the minimum length of the mesocotyl becomes 59·9 mm. The average length of the mesocotyls of all the controls (199 plants) in the gas flow experiments so far carried out is 61·4 mm., which closely approximates to the theoretical value.

It may also be mentioned that a preliminary experiment has shown that the inhibiting effect of light on mesocotyl growth takes place quite normally in the presence of a stimulatory level of carbon dioxide.

The investigation is proceeding.

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THE BOSE INSTITUTE, CALCUTTA

THE thirty-second anniversary meeting of the Bose Institute was held on November 30, under the presidency of H.E. Dr. K. N. Katju, Governor of West Bengal, when Dr. K. C. Mehta, principal of, and professor of botany in, Agra College, Agra, delivered the eleventh Acharya Jagadish Chandra Bose Memorial Lecture on "Control of Rust Epidemics of Wheat in India: a National Emergency".

In presenting his report, the director, Dr. D. M. Bose, reviewed the principal events of the past year. He stated that to meet the increased demand for additional accommodation the construction of a laboratory of floor space 5,400 sq. ft. area, above the Hall of the Institute, was being undertaken immediately, at an estimated cost of Rs. 100,000. The trustees of the Sir J. C. Bose Trust have generously placed at the disposal of the Governing Body of the Institute a donation of Rs. 50,000, to be known as "Sir J. C. Bose Contribution", towards the furtherance of the objects of the Institute and which the Governing Body has earmarked for the construction of the proposed laboratory. To meet the balance of the cost of construction the Government of West Bengal has been approached for a capital grant of an equal amount. This total amount will not be sufficient to equip the laboratory completely; a hope was expressed that other donations will be forthcoming for this purpose. The Director outlined further the building programme of the Institute. The Government of India has given a non-recurring grant of Rs. 100,000 for implementing some of the recommendations of the Reviewing Committee which, at the instance of the Central Government, visited the Bose Institute during March 1948. This amount is being utilized for the purchase of necessary workshop machinery and scientific apparatus. He announced that intimation has been received of a grant of Rs. 60,000 for a three years investigation on X-ray irradiation of oil seeds with the view of obtaining new mutants with improved economic characters. A grant of Rs. 6,000 has been received from the Burmah Oil Company (India Concessions), Ltd., for certain palæobotanical investigations which may throw some additional light on the controversial topic of the age of the Saline Series in the Salt Range, Punjab. Other grants received have raised the total amount to more than the present recurring grant of Rs. 100,000 received from the Central Government.

In reviewing the research work of the Institute, the Director mentioned that special importance is being given to the training of the younger research workers in modern technical methods like the use of high-frequency techniques of powerful sources of ultrasonic vibration, paper chromatography and of radioactive tracers. He referred to an interesting result observed in January 1949 of an increase in cosmic ray intensity associated with an intense sunspot activity. This phenomenon is of rare occurrence and not expected to be observed at the low geomagnetic latitude of Calcutta. He mentioned that a monograph will soon appear in the *Transactions* of the Institute in which the Founder's plant physiological investigations in relation to modern biological knowledge is reviewed. This year special attention is being given to the Founder's investigations on the responses in the living and the non-living.

In dealing with "Control of Rust Epidemics of Wheat in India: a National Emergency", Dr. K. C. Mehta said that in the greater part of the wheat area of India all the three rusts, black, brown and yellow, occur every year, and the black and yellow rusts also attack barley. The alternate hosts of black and brown rusts in temperate countries are of little consequence in India, and no such host has yet been found for yellow rust.

In the plants, in general, the spores that are responsible for the spread of the disease on the crop are killed soon after the harvest owing to intense heat of summer, and there is no local source of infection from the previous crop. This applies to more than 95 per cent of the wheat acreage in India. In contrast with this, all the three rusts are able to over-summer at different altitudes in the hills, which occupy scarcely 5 per cent of the entire wheat area, on 'out of season' plants. These plants 'carry over' the disease to the following crop in the hills, and rust is then blown down by wind to the plains. It is a clear case of re-introduction of the disease, year after year, from the source, that is, the hills.

Rust spores have been caught from the air at a large number of stations two to four weeks before the appearance of rust on the local crop; spores have also been caught on kites, hydrogen balloons and aeroplanes, in the last case even at an altitude of 10,000 ft.

Reckoned at current prices of wheat and barley, the approximate annual loss caused by rust comes to 200 million rupees, and in the event of a serious epidemic over large tracts of the country this figure may be doubled or even trebled, as happened in 1947.

The best method of controlling rust in the long run is to cultivate resistant varieties, and the breeding of such varieties has been in progress since 1935.

Without prejudice to the trial of partially resistant wheats in the meantime and until such time as suitable varieties are available, Dr. Mehta is convinced that a short-term plan to prohibit the *summer* crop in the hills, hilly tracts and plains of Peninsular India is essential in order to check the early outbreaks of rust in that part of the country. For control in the northern plain and the central parts, wheat and barley should be replaced by oats, fit for human consumption, as oats are not affected by any of the wheat rusts.

The adoption of these measures, intended to tackle the parasite at the source, has become a national emergency in view of the drive for self-sufficiency in food by 1951, when import of food grains is to be stopped.

ELECTRONIC INSTRUMENTS IN RESEARCH AND INDUSTRY

THE second symposium on electronic instruments in research and industry, which was organised by the Electronics Group of the Scientific Instrument Manufacturers' Association, was held in the Examination Hall, Queen Square, London, W.C.1, during November 2–4. The first Symposium (see *Nature*, 163, 294; 1949) was something of a venture, but its success was sufficient evidence that a regular function of this nature would be welcome. The organisers were, no doubt, encouraged in this view, for the scope was widened this year to include an exhibition supported by the majority of the member firms.

The symposium was opened by Sir George Thompson, who emphasized the facile manner in which electronic devices can be used for inspection, criticism and control. The first session consisted of a paper by Dr. Denis Taylor (Atomic Energy Research Establishment) on "Electronic Instrumentation in Atomic Research". Dr. Taylor outlined the use of electronic controls to maintain a specified power-level in an atomic pile and of the safety devices which ensure a complete shut-down in case of failure in any part of the system. In the measurement of radioactivity electronic devices hold a unique position, and Dr. Taylor described some of the elegant methods used for this purpose. These included monitors for checking personnel, laboratories and effluents, and a counter for the use by the modern 'forty-niner' prospecting for radioactive ores. The author emphasized that when dealing with radioactive substances no mistakes are permissible, and any device used in this field must be absolutely foolproof. The paper concluded with demonstrations of most of the items which had been described.

The next session was devoted to amplifiers, and papers on "Electronic Amplifiers" and "Magnetic Amplifiers" were read by I. L. Banks (Furzehill Laboratories, Ltd.) and A. V. Hemingway (Elliott Bros., London, Ltd.) respectively. The former dealt particularly with D.C. amplifiers and the physical factors which affect their performance in various applications. Mr. Hemingway explained the operation of the simple magnetic amplifier and showed a graphical method, analogous with that using the dynamic characteristic of the thermionic valve, for deducing the overall performance as a function of load and supply conditions. He then discussed feed-back circuits and cascade operation and the effect of various factors on response time, pointing out that in the case of cascaded amplifiers this can be less than the sum of the individual response times. The author outlined the advantages of the magnetic amplifier in certain applications and concluded with descriptions of some typical cases.

Opening the next session, C. H. W. Brookes-Smith and J. A. Colls (Southern Instruments, Ltd.) read a paper on "Some Recent Improvements in Electronic Measuring Techniques" which dealt with the measurement of pressure, stress, strain and displacement. They explained the frequency modulation system using a variable capacitance or inductance pick-up, which permits static calibration, is insensitive to random amplitude variations and which can have a level-response up to 30 kc./s. The difficulties encountered in the design of a pick-up were discussed, and some types under development were described in detail. The authors pointed out that this system and the wire-resistance strain gauge cover most of the requirements of engineers and research workers. A compact drift-corrected D.C. amplifier was described which is intended for use with either system.

Dr. H. A. Dell (Mullard Electronic Instruments, Ltd.) closed the session with a paper on "The Measurement of some Transient Phenomena", transient being defined here as applying to events of short duration repeated at regular intervals. Two examples were given which illustrated some of the problems encountered in the design of equipment for the visual delineation on a cathode-ray oscillograph of such events having low and high recurrence-frequencies respectively.

The first example was a precision polarograph for chemical analysis work using a mercury dropping electrode. The voltage across the cell during the life of each drop is compared with a calibrated standard by means of a vibrating switch, and the result is presented on an oscilloscope with suitable afterglow characteristics. Dr. Dell's second example was that of a high-speed oscillograph for the examination of radar systems and the like, in which the period between successive events is long compared with the duration of a single event. Some circuits were described which fulfil the necessary time-relationship and which can present any selected portion of the wave-form under examination.

In the final session the first paper, entitled "An Industrial Servomechanism", by P. H. Briggs (Ferranti, Ltd.), gave details of an automatic control system for accurately guiding cloth being fed on to a pin stenter or drying machine; this could be applied to certain other processes, such as paper manufacture, involving a continuous web of material. Any lateral motion of the edge of the web is detected by a photocell and the necessary correction applied by a servo device, precautions being taken to ensure a quick response with freedom from hunting. The whole equipment is designed to operate under the conditions normally encountered in a textile mill and can be worked by relatively unskilled personnel, there being only one control knob to adjust. A commendable feature is that the electronic circuit, which is of simple design, can be used in other applications.

Dr. A. J. Maddock (British Scientific Instrument Research Association) read the final paper, which was entitled "Co-operative Research at B.S.I.R.A.". He traced the history of the Association from the early days when it was concerned mainly with the problems of the optical industry, although investigations were made in other fields, two such being the production of phosphors for cathode-ray tube screens and a study of the magnetic susceptibility of the materials used for galvanometer suspensions. During the Second World War notable contributions were made to the production of graticules and to the anti-reflexion treatment of optical surfaces. The Association has recently expanded to seven departments in new premises at Chislehurst. Dr. Maddock described the facilities now available, with special reference to the Electricity and Electronics Departments, where work is in progress on such items as voltage stabilizers, D.C. and magnetic amplifiers, thermo-magnetic materials and on thermionic emission.

The session concluded with a summing-up by Mr. A. J. Philpot, the director of the Scientific Instrument Manufacturers' Association, who said that the symposium had in every sense satisfied the dictionary definition of the word, and that it had now firmly established itself in the calendar with every promise of increasing success in the future.

RHEOLOGY OF EMULSIONS

A JOINT meeting of the British Rheologists' Club and the Faraday Society was held at the Institute of Physics, 47 Belgrave Square, London, S.W.1, on November 11, Dr. G. W. Scott Blair being in the chair.

Dr. C. G. Sumner opened the discussion. He pointed out that the rheological behaviour of emulsions has much in common with that of suspensions, but certain distinctive features arise. By the use of suitable emulsifying agents, either of a given pair of immiscible liquids may be dispersed in the other, and the formation of droplets from bulk liquid is a hydrodynamic process into which the viscosities of both liquids enter. When an emulsion is caused to flow, deformation of the droplets may occur, which will reduce the apparent viscosity of the emulsion as a whole. It is doubtful whether any of the usual emulsifying machines breaks up only the liquid to be dispersed; generally both liquids are dispersed, and the effect of the emulsifying agent is seen mainly in the subsequent coagulation process; droplets of one liquid are prevented from coalescence while the others are not. In both dispersion and coagulation processes, the mechanical treatment and the relative volumes, viscosities, densities and boundary tensions of the liquids are important factors, but their precise inter-relation cannot be specified. Taylor[1] recorded photographically the elongation of a single drop of liquid subjected to viscous drag in a second liquid, finding the effect of the viscosity of the drop relative to that of the external liquid to be striking, and some of his observations were afterwards given a mathematical basis by Timotika[2]. From Clay's[3] experiments it appears likely that the bursting of droplets in turbulent flow takes place by a mechanism similar to that in the jet of an oil atomizer. The chances that a drop will burst decrease rapidly with the radius of the droplet below a certain value.

Regarding the stability of emulsions, there are three ways in which the system can become less homogeneous: (i) by 'creaming', that is, by concentration of globules of the disperse phase towards the top or bottom of the emulsion; (ii) by clumping of individual globules without coalescence; (iii) by coalescence of globules to form larger drops and eventually bulk liquid. Only the third represents instability in the sense of a reversal of the emulsification process; but creaming may be objectionable and is usually minimized by fine dispersion and the addition of thickening agents to the external phase. Such thickening agents are generally materials which form viscous or thixotropic sols with the dispersion medium. There seems no doubt that the viscosity of the emulsion as a whole is closely related to the ease of emulsification, and the implication is that in the most stable emulsions the globules have a sufficiently low residual interfacial energy against the external phase to be substantially independent of one another. From the practical point of view, an emulsion with some tendency to thixotropy will be preferable to one with the minimum resistance to flocculation, since the latter will cream more readily. With certain emulsifying agents the stability of the emulsion obtained is dependent on the relative volumes of the phases, the concentration of agent and the mechanical treatment of the emulsion. Such systems are prone to show phase-type inversions or multiple emulsions, with abrupt changes in viscosity.

Most of the published work on the viscosity of emulsions has been carried out in connexion with the testing of equations relating the viscosity of an emulsion to that of the dispersion medium. Of such equations may be mentioned those of Taylor[4], Leviton and Leighton[5], Richardson[6], Broughton and Squires[7] and Hatschek[8]. A comprehensive series of experiments to test Hatschek's conclusions has been made by Sibree[9], who finds poor agreement between observed and calculated values, although an improvement in the equation may be effected by the introduction of a 'volume factor'. This is confirmed by Gabriel[10]. Richardson[6] has developed an equation connecting apparent viscosity at an arbitrary rate of shear with the volume concentration. The work of Broughton and Squires[7] has given a clear demonstration of the importance of the emulsifying agent in determining the viscosity of the emulsion. The works of Toms[11], Lyttleton and Traxler[12] and Eilers[13] is also of interest in this connexion. No quantitative theory appears to have been advanced to account for the observed dependence of the viscosity of emulsions on the mean globule-size or the size distribution; homogenization of an emulsion increases its viscosity, sometimes considerably.

Our knowledge of this subject is still sketchy, Dr. Sumner concluded. In the past there has been a tendency to treat the flow of emulsions as an operation in solid geometry and mechanics; but it is now clear that the rheological behaviour is intimately connected with the nature of the interfacial film or phase, and the influence of globule-size distribution is more important than has hitherto been supposed.

In the ensuing discussion, Dr. A. H. Nissan mentioned that the constant of 2·5 in all the equations referred to is simply the value for the most probable range of globule-sizes. The size-range is important, and for uniform globules the constant may be as much as 4·3. Dr. Scott Blair remarked that Anstein and Reiner had shown that the Einstein law, including the 2·5, holds for cement mortars of viscosity about 10^{17}. Mr. A. de Waele directed attention to the fact that the equations of Richardson and of Broughton and Squires are approximations for the case when the viscosity ratio is nearly unity; some workers have lost sight of this and used them when the viscosity ratio is ten or more.

Milk as an Emulsion

Dr. R. Aschaffenburg continued with an account of "Milk as an Emulsion". Milk consists of an aqueous phase containing salts, lactose and colloids (mainly proteins) into which is dispersed fat. Though perhaps the most perfect single food, milk is not perfect as an emulsion because of its tendency to 'cream', which, however, may be overcome by homogenization. The slow break-up of this emulsion is possibly an aid to digestion. The size of the fat globules varies from $0{\cdot}1\,\mu$ to $10\,\mu$; the size distribution depends upon several factors. The number of globules is very large: the weekly three-pint non-priority milk ration in Britain contains about five thousand billion globules. Apart from creaming, the emulsion is stable, and it is not possible to extract the fat directly with solvents. About 1840 Ascherson suggested that this was due to a 'membrane' around the fat globules, and subsequent work, especially by L. S. Palmer, has confirmed this view. Electron microscope pictures of the fat globules, indeed, show each one surrounded by a dark layer and a hazy region, but the interpretation of such pictures is still the subject of much controversy.

The rising of cream is predominantly an effect of gravity, but, on account of clustering of the globules, the rate of rise is greater than would be expected from Stokes's law. Clustering is due to the presence, in milk, of an 'agglutinin' which, like bacterial agglutinins, is of a globulin nature.

Butter is now prepared by three main processes: (i) the classical method of churning, (ii) by the preparation of cream of a much higher fat percentage (about 80 per cent), followed by cooling and mechanical working, (iii) by the preparation of the 80 per cent fat cream, its conversion to pure butter oil and subsequent emulsification with the right amount of water, whey or skim milk. The classical method is a kind of flotation process with foam enrichment; it works best when the fat is neither completely 'solid' nor completely 'liquid', but it is not known why this should be so. Milk has a minimum foam stability at 20–30°, which has been shown to be due to the fat. Butter is not a straightforward oil–water emulsion, and its rheological properties vary with the method of manufacture. These properties offer an interesting field for further research.

Formation and Flow of Emulsions

Dr. E. G. Richardson, in a paper on "The Formation and Flow of Emulsions", said that there are two basic processes of emulsion manufacture. Either one liquid is squirted into another, or the two liquids are allowed to mix in turbulent motion. The first is the problem of the break-up of a liquid under the combined actions of the interfacial tension and the relative viscosity. In the main there are three types of such disintegration. In the first type, the jet becomes varicose. Rayleigh[14] has examined the conditions for this to take place, and Tyler and Richardson[15] have taken photographs of this type of break-up from capillary jets. In the second type, the jet becomes sinuous, and the resistance to the passage of the 'humps' becomes more important than the surface tension. This type has been dealt with mathematically by Weber[16], and both Tyler[17] and Ohmesorge[18] have given criteria for the critical velocities for the change from the varicose to the sinuous forms. At high velocities in excess of the critical value, break-up is controlled by viscous and inertial forces. At low speeds, drops are formed when the varicosities acquire an amplitude sufficient to nick off the jet, and so tend to be of uniform size; whereas at high speed the drops are formed as 'lumps' sheared off the periphery and tend to show a greater dispersion of size.

Dr. Richardson showed photographs of jets and the results of drop-size measurements for jets of aniline, paraffin and oil, and benzene into water for different nozzle sizes and velocities. When jets issue from *large* nozzles at *low* speeds, the drops tend to oscillate about the spherical shape and eventually to burst into fragments. Such effects of deformation and circulation have been investigated by Bond and Newton[19], and Taylor[4] has obtained an expression for the upper limit to the size of drop which can subsist while the fluid is being sheared. It is also possible to influence drop-size by acoustic agitation, and it appears that ultrasonic agitation can be used to produce greater fineness and uniformity of dispersion.

Regarding the flow of an emulsion, once formed, the viscosity is affected by (i) concentration of dispersed phase, (ii) drop-size distribution, (iii) rate of shear. In most practical emulsions the drops are so small that they act as rigid spheres when the emulsion is sheared. Experiments with benzene and water show that the viscosity increases rapidly with the concentration of the disperse phase, such that

$$\log \eta/\eta_0 = \chi c,$$

where η and η_0 are the viscosities of emulsion and 'solvent', c is the concentration and χ is a sort of 'interphasal' compressibility. Broughton and Squires[7] write

$$\log \eta/\eta_0 = \chi(c + c_0),$$

where c_0 is an intercept on the axis.

The variations of viscosity can be given a partial explanation by supposing the process of shearing the emulsion to cause one row of globules to pass over another row. Slow motion will cause an upper row to pass over a lower row through a series of 'humps'. At higher rates of shear, the upper globules are supposed to 'jump' over the lower depressions without falling right in, and the viscous traction concerned in lifting them out of the 'hole' is less. Unpublished experiments by Iskander and Richardson on the effect of globule-size on viscosity show that the limiting viscosity at the highest rates of shear is roughly inversely proportional to the mean globule-size.

In the discussion on this paper, Mr. A. K. Soper took exception to the Broughton and Squires equation involving an intercept c_0 on the axis; Dr. A. S. C. Lawrence said that there was some evidence for the existence of an elastic skin around the globules. Mr. de Waele said that in solid–liquid systems there appears to be such a barrier, for the difference between the theoretical packing limit of 74 per cent for uniform spheres and the actual practical limit may be considerable. With a certain carbon black ($0 \cdot 03\,\mu$–$0 \cdot 20\,\mu$) it is impossible to get more than 20 per cent into oil, and the product is not thixotropic —it fractures like a solid. With ½-μ particles one gets nearer the theoretical 74 per cent limit, and then only does the phenomenon of dilatancy arise. The existence of a barrier layer would increase the stability of an emulsion.

Mr. J. E. Adamson remarked that globule-size distribution should be specified more precisely: in the simplest case of a Gaussian population, two factors are required (mean and standard deviation), and with more complicated distributions the moments about the mean must be considered. Dr. A. H. Nissan said that the flow of water through glass filters at various temperatures cannot be accounted for by viscosity effects alone, but one can get similar effects by adding materials which change the surface tension. This may be due to the formation of a surface layer on the glass which interferes with the normal mechanism of flow. Dr. W. H. Banks denied this, and said that it is very difficult in such experiments to be sure that the glass is not swollen; the electro-viscous effect must be taken into account.

V. G. W. HARRISON

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GENETICS AT THE UNIVERSITY OF GLASGOW

WITH the recent opening of new premises for the Department of Genetics, the development of teaching and research in genetics at the University of Glasgow has gone a step further. Of the two floors of the building, the top one is for research and can accommodate up to ten research workers in small laboratories; the ground floor is reserved for undergraduate teaching and has laboratory accommodation and services for up to fifteen students.

The research laboratories are suitable for any kind of genetical research with plants or animals, though the equipment has been chosen mainly in view of expanding the work with micro-organisms, the field of genetical research which has been in the forefront in Glasgow since 1943. The long-term line of research in the Department is an approach to the spatial–temporal organisation of biochemical processes in the cell, using the biochemical genetics of micro-organisms as a tool. Of the innumerable problems arising from this approach, those under actual investigation at present include the formal genetics of *Aspergillus nidulans* (a first systematic attempt to work with a homothallic species); the cytogenetics of a mycetozoon; the study of nuclear and cytoplasmic control of 'adaptive' enzyme systems; and the biochemical genetics of those biosyntheses which involve steps of millimicromolar order. Some of these problems have obvious implications for applied fields, for example, pathology, industrial fermentations, etc., and their investigation has received support in the form of research grants, scholarships or fellowships from the Medical Research Council, the Department of Scientific and Industrial Research, the Agricultural Research Council, the Carnegie Trust for the Universities of Scotland, the Brewing Industry Research Foundation and the Research Department of the Distillers Company, Ltd. The present number of graduates, including staff, engaged in research is eight.

As for the undergraduate teaching in genetics, the University of Glasgow has embarked on a bold experiment. The establishment in 1945 of an independent lectureship in genetics, soon after to become a Department, meant that it was realized that the teaching of this subject cuts across the traditional main partition of the teaching of biology into botany and zoology ; in other words, the fundamentals of genetics (though not necessarily advanced study) must be taught in the same way to all students of biological subjects. Turning this consensus into practical application requires considerable adjustments in regulations, time-tables, curricula, etc., besides the building up of teaching staff and the organisation of lectures and practical classes : it has taken about four years to do this, and the present position of the teaching of genetics in the Faculty of Science is as follows. Instruction in genetics has been removed from the courses in botany or zoology ; but students intending to read for honours in either subject are advised to take Course I in genetics as a subsidiary. Genetics has been included among the subjects for both ordinary and honours B.Sc. The honours curriculum includes three courses (I, II and III), each extending over three terms ; Course I (70 lectures and 60 practical classes) can also be taken by any student in the Faculty of Science who has already passed first-year botany or zoology ; Courses II and III can be taken only in combination with an honours curriculum in botany, or zoology, or biochemistry or physiology, the minimum time for such combined honours being four years.

It will take a few years to tell whether the solution adopted at Glasgow has been a wise one, and no doubt experience will suggest modifications.

ROYAL SOCIETY INFORMATION SERVICES COMMITTEE

IT is already clear that the outcome of the Royal Society Scientific Information Conference in June–July 1948 will be much more than the admirable volume recording its proceedings and recommendations which followed. To carry out these recommendations and to implement the work of the Conference generally, the Council of the Royal Society set up an Information Services Committee, under the chairmanship of Sir Alfred Egerton, and this Committee held its first meeting on November 23, 1948. One of the first acts of the Committee was the establishment of an Abstracting Services Consultative Committee, an account of the work of which, by its chairman, Dr. G. M. Findlay, was recently published in *Chemistry and Industry* (819; 1949). This has since been followed by an official report of the activities of the Information Services Committee itself for the year ending October 31, 1949. Besides this, the Lord President of the Council, on accepting the invitation of the Scientific Information Conference to consider improvements in the national central scientific libraries and information services, called upon the Panel on Technical Information Services of the Committee on Industrial Productivity to review the situation and make recommendations. The Information Services Committee is already considering a report from the Panel entitled "Report on Scientific and Technical Library Facilities", while there has also been published in the *Library Association Record* of December 1949 a report on "The Co-operative Provision of Books, Periodicals and Related Material" from a 'working party' on library and information services, set up by the Council of the Library Association in January 1949 at the request of its University and Research Section.

This latter report, which is in two parts, the second outlining a basic plan for a national library service, comprising the national libraries, a series of first-line and a series of second-line special libraries, major regional reference libraries, and lending libraries, and involving as a first stage the compilation of a directory of libraries in Great Britain and Northern Ireland, including a survey of specialist resources of all libraries, has already been forwarded both to the Royal Society and to the Information Services Panel. The Council of the Library Association has also asked the 'working party' to hold discussions with representatives of the British Museum, the National Central Library, the National Committee on Regional Library Co-operation, the Science Library and Aslib, and to compile a pilot survey in engineering and the fine arts to ascertain the probable extent of co-operation and estimated additional expenditure to obtain complete coverage. A more detailed report is then to be prepared on the basis of this survey, and it will be noted from the report of the Information Services Committee that that Committee has already welcomed the co-operation of the Library Association in this field.

The recommendations of the Royal Society Conference are set out in a paper issued by the Royal Society on August 5, 1948, and this has been the basic working paper for the Committee. The recommendations were classified by the Committee into eight groups, according to subject-matter and then again according to whether they could be committed for action to various specified bodies, whether they required further study by individual members of the committee with the view of recommending action later, or whether they required wider investigation by sub-committees or by the Committee as a whole. Co-operation has also been secured from overseas delegates and the organisations they represented, and whenever appropriate with the United Nations Educational, Scientific and Cultural Organisation. A major part of the sixth meeting of the Committee was devoted to the brief of the British delegation to the Unesco Conference on Science Abstracting in Paris in June 1949.

As regards the other general recommendations, proposals have been made for the initiation of further research into the use of scientific literature, but no specific programme has been begun. A sub-committee has collected from some fifty scientific publishing bodies their instructions to authors, and has drafted a concise general pamphlet which is being submitted for informal comment and which the Information Services Committee proposes to invite the Council of the Royal Society to authorize for issue to universities, government and industrial research establishments in the hope that younger scientific men in particular may be assisted thereby to improve the writing of scientific papers.

Comments of scientific societies on a recommendation that funds should be made available to provide facilities for the work of editors and publication boards have led the Committee to recommend to the Council of the Royal Society that efforts should be made to obtain an increase in the Parliamentary grant-in-aid of scientific publications administered by the Society, and to extend its scope to cover additional editorial staff and facilities as well as printing costs. The Biological Council has been invited to report on the effectiveness of its calling together the editors of periodicals dealing with the biological sciences with a view to similar collaboration elsewhere, but the suggestion regarding the publication of précis journals was not welcomed. The action taken in regard to fair copying has already been reported in *Nature* (164, 289; 1949).

The Abstracting Services Committee believes that improvement is possible in the preparation of authors' summaries or synopses, and has accordingly prepared a leaflet, "Guide for the Preparation of Synopses", which has been sent to scientific societies and other publishers of scientific journals with two recommendations endorsed by the Council of the Royal Society. These recommendations, that every paper in a scientific journal should be accompanied by a synopsis or précis, independent of the text and figures, and preferably at the beginning of the paper, and that these synopses should be subject to the same editorial scrutiny and correction as the full paper, have been copied by Unesco, and the leaflet has been in extensive demand. The Committee also supervised the compilation of a comprehensive list of journals, etc., containing abstracts, and this was issued in June 1949 (see *Nature*, 164, 692; 1949). The British delegation to the Unesco Conference on Scientific Abstracting consisted of Dr. C. H. Desch, Dr. L. H. Lampitt and Mr. H. T. Pledge, and at the Conference the suggestion that the model of the Abstracting Services Committee should be followed elsewhere was adopted. Following a survey of the practice of more than one hundred British abstracting journals, the Abstracting Services Committee is inviting all abstracting agencies to co-operate towards the general adoption of a standard method of quoting references which the Committee has drafted. Consultation with scientific societies also showed that many societies which do not at present publish the titles of new papers accepted for publication before the papers appear in print have indicated their intention to do so in the future.

The Information Services Committee has also formed a sub-committee under the chairmanship of Prof. J. D. Bernal for further study of classification, but while a specific recommendation relating to the evaluation of new alternative systems of chemical notation has been referred to the International Union of Pure and Applied Chemistry, no significant developments are reported in mechanical methods of indexing and selection. The recommendation that the Publishers' Association be invited to arrange the issue of suitable unit catalogue cards for all British scientific and technical books is considered to have been satisfied by the scheme to be introduced by the British National Bibliography. The Committee is unable to act directly on most of the recommendations relating to aids for information services but has forwarded them to the authorities concerned. Thus, the Federation of British Industries was invited to prepare a directory of industrial research, and the Department of Scientific and Industrial Research to issue a directory of centres of highly specialized research. The Committee has accepted the recommendation of the Panel on Technical Information Services that compilation and publication of a comprehensive index of research activities and specialized knowledge of individual scientific workers is inadvisable at present. An exhaustive study of the need for improved special dictionaries and the fixing of interlingual equivalents for scientific terms has been made by Dr. J. E. Holmstrom, and the results are incorporated in a report issued by Unesco. In this report, which is provided with a bibliography giving particulars of 550 interlingual dictionaries, Dr. Holmstrom suggests that the efforts at present being made to standardize technical terms should be co-ordinated under an International Terminological Bureau to be established by Unesco which, besides conducting research, would maintain relations with all the federations and societies concerned and provide central services. The Bureau would collect and index definitions and technological equivalents which have been used or proposed by individual translators but have not yet been included in known dictionaries, and would issue them to inquirers on demand. It would also offer such definitions and equivalents for official approval as occasion arose, and the approved definitions and equivalents when printed would be distinguished by a suitable symbol to indicate this official approval.

The Information Services Committee has experimental evidence of the value of an agency equipped with special typing facilities, and warmly supports a proposal which has been submitted to the Royal Society, especially for dealing with the acute letterpress difficulties that arise in the field of mathematics. The Committee decided to delay action on the recommendation that permanent relations be established with representative printing organisations until the effect of improvements which had reduced the delays in the publication of original scientific papers could be assessed, but has recommended the formation of a small consultative committee with representatives from the British Federation of Master Printers and the Printing and Kindred Trades Federation. It has also encouraged the publication of an article on photographic methods of documentary reproduction, and recommended that the Department of Scientific and Industrial Research should initiate and encourage research on methods of photo-copying which do not require the use of silver salts, and especially of methods making it possible to obtain reductions and enlargements.

SUPPLY AND DEMAND FOR PROFESSIONAL ELECTRICAL ENGINEERS

A GROUP of sub-committees under the general direction of the Technical Personnel Committee has been engaged for a period of some two years in carrying out a comprehensive survey of the probable future demands in Great Britain for professional personnel in the various branches of science and engineering. The report of the Electrical Engineers' Panel of the Engineering Sub-Committee has recently been published (London: H.M. Stationery Office, 6*d*. net). The Panel was under the chairmanship of Sir Arthur Fleming, who has an intimate personal knowledge of the employment of professional electrical engineers in manufacturing industry extending over a long period.

The scope of the investigation covered the assessment of the requirements of the main divisions of the profession and a comparison of this estimate with the existing supply. The estimated annual demand over the next five years is summarized as follows.

Public service (including the Armed Forces, government departments and public bodies such as the National Coal Board and British Electricity Authority)	660
Industry (including research associations)	900
Teaching (universities and technical colleges)	50
Consultants	10
Emigration and miscellaneous	50
	1,670

The annual supply up to 1950 is estimated at 1,550, made up as follows.

University output	500
From full-time courses in technical colleges	150
Higher National Certificates (credit standard)	600
Miscellaneous (including entry by the examinations of the Institution of Electrical Engineers)	300
	1,550

There is thus an estimated annual deficiency of the order of ten per cent. It is concluded that, as there is good ground for expecting an increase of output from the universities and technical colleges, resulting in the main from the substantial building programme which is in progress and the increase in the number of available scholarships, the deficiency is likely to be met by the provisions already in hand. The opinion is expressed that the requirements of industry generally "tended to be higher in the immediate future than was likely to be the case in subsequent years".

While the report is concerned specifically with professional engineers, an interesting incidental comment is made in regard to technicians. In general terms, the distinction between the professional engineer and the technician is made in respect of the professional engineer's ability to take personal responsibility for development in electrical engineering, while the technician will normally carry out technical work in accordance with established practice or under direction. It is estimated that the average ratio of the number of technicians to the number of professional engineers will be of the order of five to one. The report does not consider the adequacy of the supply of technicians, but it may be remarked in passing that there is evidence of a distinct shortage of this class of personnel.

While, as the report points out, no claim can be made for the accuracy of the estimates given, this document constitutes a valuable summary of informed opinion upon an important subject.

CORRECTED KRYPTON WAVE-LENGTHS

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I USED a reflecting echelon to measure vacuum wave-lengths of thirty-one lines in the arc spectrum of krypton in terms of the cadmium red standard[1]. The dispersion formula of Barrell and Sears[2] and of Perreau[3] for pure air and carbon dioxide respectively were used to calculate the wave-lengths in 'normal' air (air at 15° C. and 760 mm. pressure containing 0·03 per cent carbon dioxide). These were found to differ appreciably from those recommended by the International Astronomical Union, although very close agreement was obtained when the dispersion formula due to Kosters and Lampe[4] or Perard[5] was employed. Barrell and Bruce have pointed out that this discrepancy lies outside the error which could be attributed to difference between the three dispersion formulæ, and further examination has revealed an arithmetical error in the application of the dispersion formula of Barrell and Sears.

The amended wave-lengths in 'normal' air are tabulated herewith, being calculated by each of the three dispersion formulæ. Where the International Astronomical Union wave-lengths are not available, Jackson's[6] are quoted and marked (J) accordingly. For simplicity, only fractional portions of wave-lengths are given in the last three columns. Each formula leads to a slightly different primary vacuum wave-length standard, since the wave-length of the cadmium red line 6438·4696 is specified in 'normal' air. Corresponding changes appear in the vacuum wave-lengths, and these are used in calculating the 'normal' air wave-lengths appropriate to each formula.

It will be observed that when the calculation is carried out in this way, differences between 'normal' air wave-lengths obtained by each of the three dispersion formulæ do not differ by more than three in the fourth decimal place of an Angstrom unit. The mean difference between these wave-lengths and those of the International Astronomical Union is + 0·0003 A., which is the order of the standard deviation of the vacuum wave-length measurements.

This work is being repeated using a more refined technique and at the same time being extended into the near ultra-violet. I am most grateful to Mr. H. Barrell, of the National Physical Laboratory, Teddington, and to Mr. C. F. Bruce, of the Australian National Standards Laboratory, Chippendale, N.S.W., for their assistance in this matter.

International Astronomical Union	Barrell and Sears	Kosters and Lampe	Perard
4273·9700	0·9703	0·9703	0·9704
4282·9683	0·9681	0·9681	0·9682
4286·4873	0·4869	0·4869	0·4870
4300·4877	0·4861	0·4861	0·4862
4318·5525	0·5528	0·5528	0·5529
4319·5797	0·5805	0·5805	0·5806
4351·3607	0·3603	0·3604	0·3605
4362·6423	0·6420	0·6422	0·6423
4376·1220	0·1226	0·1227	0·1229
4399·9670	0·9673	0·9674	0·9675
4425·1906 (J)	0·1904	0·1905	0·1906
4453·9179	0·9183	0·9184	0·9185
4463·6903	0·6906	0·6908	0·6909
4502·3547	0·3549	0·3550	0·3552
5562·2257	0·2279	0·2280	0·2281
5570·2895	0·2902	0·2903	0·2904
5580·388 (J)	0·3888	0·3890	0·3891
5649·5628	0·5627	0·5628	0·5629
5672·4519 (J)	0·4512	0·4514	0 4515
5707·512 (J)	0·5127	0·5128	0·5129
5832·859 (J)	0·8599	0·8600	0·8601
5866	0·7514	0·7514	0·7515
5870·9158	0·9168	0·9169	0·9170
5879·9000 (J)	0·9003	0·9005	0·9005
5993·8503	0·8513	0·8514	0·8515
6012·1570 (J)	0·1569	0·1571	0·1571
6056·1280 (J)	0·1274	0·1275	0·1276
6082	0·8629	0·8630	0·8630
6236·354 (J)	0·3519	0·3520	0·3521
6421·029	0·0285	0·0285	0·0285
6456·291	0·2910	0·2910	0·2910

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Flight Recorders: a Technique for the Study of Bird Navigation

In experiments on the homing ability of birds, it would obviously be a great advantage if one knew the actual time spent in flying by a bird which had been released some way from home and which had returned after a known time. Mere knowledge of the time between release and return can only provide an upper limit for the effort expended by the bird in regaining home: in practice, the real flying time may be very much less than this, and knowledge of it is vital in deciding for or against hypotheses involving search or some real navigational ability. Following the bird by light aeroplane has been accomplished[1]: this technique, though very powerful, is cumbersome and cannot cope with a homing flight of some days. Exner[2] has used a method dependent on the different rates of evaporation of camphor in still and moving air to measure the flying time, but this method is susceptible of only very limited accuracy; nevertheless it constitutes the first, and very early, attempt to measure the flying time.

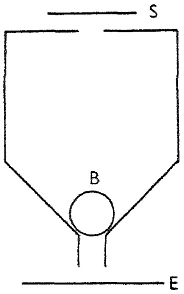

Fig. 1

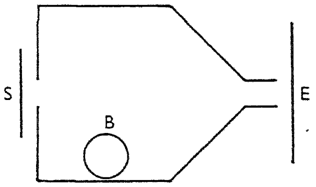

Fig. 2

An accurate measure of the flying time may be achieved using the instrument which is illustrated schematically in Figs. 1 and 2. *S* is a source of α-particles, *E* a piece of photographic emulsion and *B* a steel ball. The instrument is fixed to the bird in such a way that, when it is at rest, the orientation of Fig. 1 is assumed (to within 45°); the α-particles strike the steel ball and do not reach the emulsion. When the bird flies, the orientation of Fig. 2 is approximated to, *B* rolls out of the way and the α-particles strike the emulsion. If the emulsion is processed and examined under a microscope, the tracks of the individual α-particles may be very easily seen and counted, their number measuring the time for which the bird has been flying. The instrument has dimensions of roughly 8 mm. × 5 mm. and, when assembled, weighs 250 mgm. If an accuracy of 2 per cent or better is required in the knowledge of the flight-time, a ratio of 20 or so is permitted between the longest and shortest flight times: if the accuracy is 10 per cent, this factor rises to 500. Any time-scale from minutes to weeks may be catered for with equal accuracy. This instrument has been used on large-scale experiments on the homing of domestic pigeons (fixed to the wing). These experiments have been performed in collaboration with Mr. G. V. T. Matthews, whom I would like to thank for his help with the testing of the device.

Modifications of the method suggest themselves. Thus an instrument has been made and tested in which the α-particle source is mounted on a small inertia arm. This instrument records only flapping flight and not soaring or gliding. It is hoped to incorporate a compass card in such a way that the time spent flying in various directions should be revealed. A device recording the time spent on water could be constructed, the water filling a small absorption cell between the source and film.

Thanks are due to Dr. A. G. Maddock for help with the sources, to Mr. D. D. Stewart for his mechanical skill, and to Dr. C. Waller of Messrs. Ilford, Ltd., for supplying the emulsion.

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Nov. 20.

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A New Human Blood Group

During the investigation of a hæmolytic transfusion reaction, it was observed that the patient's serum contained an *iso*antibody the reactions of which did not correspond with those of known blood group systems. The patient was a hæmophilic who had received previous transfusions. His serum contained two immune antibodies, namely, anti-*Rh* and a second antibody which reacted with a large proportion of group *O Rh*-negative bloods; this second antibody could be detected with certainty only by the indirect Coombs test.

The patient's red cells were found to have the following characteristics: *O, cde/cde, MN.S, P+, Kell−, Lutheran−, Le(a− b+)*; it could be deduced that the patient possessed the Le^a gene, since he secreted the Le^a substance in his saliva[1]. It was theoretically possible for the patient to have formed the following antibodies outside the *Rh*-system: anti-*s*, anti-*p*, anti-*Kell* or anti-*Lutheran*. The patient's serum was tested against a large number of blood samples, in parallel with appropriate sera (anti-*S*, etc.); and it became clear that the antibody was reacting with a factor unrelated to these systems. The patient's serum has been tested against blood samples from 180 unrelated adults; 66 per cent of the reactions were positive. The incidence of positive reactions appears to be independent of the *ABO*- and *Rh*-group of the bloods tested.

The inheritance of the factor is being investigated. Families have been encountered where both parents possess the factor but produce offspring whose blood lacks the factor. It is therefore evident that the blood of heterozygotes reacts with the serum.

The following notation is proposed: the system may be called *Duffy* (by permission of the patient). Following the suggested notation for the Lewis group system[2], the antigen with which the patient's serum reacts may be called Fy^a, and this symbol may also be used for the gene determining this antigen; one may postulate an allele Fy^b. From our data the following approximate gene frequencies may be calculated: $Fy^a = 0{\cdot}41$; $Fy^b = 0{\cdot}59$.

A full account of these investigations will be published elsewhere.

We are grateful to Dr. G. Plaut, of the North London Blood Supply Depot, for a very large number of samples of *Rh*-negative blood; to Dr. W. J. T. Morgan for supplying anti-Le^a and anti-Le^b sera and for testing the saliva of the patient; to Dr. A. E. Mourant for supplies of some of the other rare sera; to Miss Elizabeth Ikin for testing the serum against a panel of human bloods, and confirming that it could not be reacting with any factor within the systems at present recognized; and to Dr. R. R. Race for advice on nomenclature.

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Effect of Posterior Pituitary Extract and its Fractions on Renal Electrolyte Excretion

It seems to be generally accepted that, in addition to its antidiuretic effect, posterior pituitary extract has a chloruretic action. All workers appear to have found an increase of chloride concentration in the urine; but there is by no means unanimity whether the actual amounts excreted are increased, results varying with the species and experimental conditions (see, for example, Shannon[1] and O'Connor[2]). Furthermore, it is not clear which of the posterior pituitary fractions is mainly responsible for the chloruretic effect, and which ions are excreted with the chloride.

Some observations on this subject have been recently published by O. Schaumann[3,4], who investigated the action of oxytocin and of vasopressin on the renal excretion of chloride, sodium and potassium ions in rats. We have been engaged in similar experiments. The effect of small doses (3 milliunits/100 gm. s.c.) of 'Pitocin', 'Pitressin' and 'Pituitrin' on the chloride excretion of hydrated rats was first investigated. It was found that the changes in the rate of chloride excretion obtained with 'Pituitrin' and 'Pitressin' coincided—as might have been expected—with the antidiuretic effect. The duration of the antidiuretic effect was therefore used to determine the urine-collecting period. The effect of the injection of posterior pituitary extracts on the rate of chloride, sodium and potassium ion excretion was then studied in rats on standard and sodium chloride-enriched diets.

	K		Na		Cl		Unknown ions	
	*a**	*b***	*a*	*b*	*a*	*b*	*a*	*b*
Controls (micro-mol./100 gm. rat/min.)	0·13	0·22	0·24	0·15	0·19	0·13	0·18	0·24
Ratio 'Pitocin'/controls	2·4	2·1	1·0	1·0	0·9	2·1	2·1	1·4
Ratio 'Pitressin'/controls	1·7	1·2	0·4	0·7	0·5	1·2	1·2	0·8
Ratio 'Pituitrin'/controls	2·2	1·7	1·2	1·6	1·6	3·3	1·4	0·9

*, Rats on standard diet. **, Rats on sodium chloride-enriched diet.

It will be seen from the accompanying table that both 'Pitocin' and 'Pitressin' increased the rate of potassium excretion, but that 'Pitressin' depressed the excretion of sodium. The effects of the posterior pituitary fractions on chloride excretion appeared to depend on the chloride content of the diet. It will also be noted that the effect of 'Pituitrin' on our rats resembled that of 'Pitocin' rather than that of 'Pitressin'. Schaumann[4] used doses more than ten times greater than ours, and it is difficult therefore, to relate his results to ours, particularly as even the small doses used by us are known to have marked effects on the glomerular filtration-rate in rats (Dicker and Heller[5]). Our experiments are being extended to determine to what extent changes in glomerular filtration-rate produced by the posterior pituitary principles bear on renal electrolyte excretion.

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Effect of Hæmagglutinating Viruses on the Electrophoretic Mobility of Human Erythrocytes

The enzymic activity of influenza viruses, recently characterized in chemical terms for the substrate ovomucin[1], was first suggested by Hirst[2], who showed that, following the agglutination of erythrocytes, the virus was eluted spontaneously, leaving the cells inagglutinable by the same strain. Burnet, McCrea and Stone[3] found that cells from which one strain had become eluted were still agglutinable by certain other strains. The arrangement of influenza *A* and *B*, mumps and Newcastle disease viruses in the order of their progressive action on cellular receptors was termed the 'receptor gradient'. Elucidation of this unique enzyme-substrate relationship, characterized by the varying *extent* of interaction, is limited by the qualitative nature of the biological method. The finding of Hanig[4] that, following treatment with the *PR*8 strain of influenza virus, the electrophoretic mobility of human erythrocytes was markedly reduced, suggested a biophysical approach to the problem.

Human cells were incubated at 37° C. with excess amounts of the viruses shown in the accompanying table for periods sufficient to allow the reaction to proceed to completion, as judged by changes in agglutinability and electrophoretic mobility. Except in the case of Newcastle disease and mumps viruses, cells were stabilized with immune serum before testing[3]. Microelectrophoresis was carried out at 25° C. in an $M/15$ phosphate buffer of pH 7·35 after the method of Moyer[5].

The results show that with each virus the loss of agglutinability is accompanied by a reduction in mobility, corresponding, in most cases, with the position of the virus in the receptor gradient. Newcastle disease virus, however, reduces the mobility to a value considerably lower than would be expected from the loss in agglutinability. In this connexion, it is of interest that cells treated with Newcastle disease virus previously heated in phosphate buffer show a mobility of 0·90, although the change in agglutinability is similar to that with unheated virus[6]. Though detailed work with swine influenza virus has shown that it lies above *MIL* in the gradient, the reduction in mobility is considerably greater than that obtained with any other virus tested. It is possible that further investigation will yield lower values for *LEE* and *MIL*, as cells treated with these strains have always been agglutinable by the homologous virus. Cells treated with the receptor-destroying enzyme of *V. choleræ* show a very low mobility in accordance with their complete loss of agglutinability. Minor variations in the mobility of different samples of treated cells were usually reflected in similar variations in agglutinability.

Treatment of cells	Agglutination by standard dose of virus								Electrophoretic mobility*
	Mumps	*NDV*	*MEL* (*A*)	*PR8* (*A*)	*BEL* (*A*)	*LEE* (*B*)	Swine	*MIL* (*B*)	
Mumps	–	+	++	++	++	++	++	++	1·18
Newcastle disease virus	–	–	–	+	++	++	++	++	0·51
MEL (*A*)	–	–	–	+	++	++	++	++	0·78
PR8 (*A*)	–	–	–	–	+	++	++	++	0·74
BEL (*A*)	–	–	–	–	–	++	++	++	0·75
LEE (*B*)	–	–	–	–	–	++	++	++	0·74
Swine	–	–	–	–	–	–	–	+	0·34
MIL (*B*)	–	–	–	–	–	–	++	++	0·68
Receptor-destroying enzyme of *V. choleræ*	–	–	–	–	–	–	–	–	0·17
Nil	++	++	++	++	++	++	++	++	1·30

(*A*), (*B*) = influenza virus type *A*, *B*. * Expressed in μsec./volt/cm. Values given are the averages of several samples.

The biological gradient was further studied by determining the additive effects of successive treatments with different viruses or of one virus followed by the receptor-destroying enzyme of *V. choleræ*. The loss of agglutinability and, with the exception of experiments involving Newcastle disease virus, the change in mobility, was the same after the double treatment as after exposure to the second agent only. The action of a second virus following Newcastle disease virus resulted in a lower mobility value than was given by the second virus itself. Additional experiments with Newcastle disease virus, carried out in collaboration with Prof. F. M. Burnet, have indicated that the reaction of this virus with erythrocytes is more complex than that of the other viruses tested.

It is evident that the receptor gradient can now be expressed in quantitative terms, and it is hoped that this will lead to a fuller understanding of the phenomenon. That agglutinability is not a function of the total residual charge of the cell, however, is exemplified by the relatively slight loss of agglutinability of cells treated with Newcastle disease virus, despite their low mobility.

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Yellow Pigments of the *Aspergillus niger* Group

The formation of yellow pigments by the *A. niger* group has been frequently reported. Frey[1] reported two pigments: brown aspergillin and a golden-yellow pigment. Roussy[2,3] reported the production of yellow pigments by this group in fatty media; but Pontillon[4] showed that the pigment production was due to the removal of essential salts during the preparation of the medium. Lavollay and Laborey[5-7] showed that growth on magnesium-deficient media produced riboflavin; Giordani[8] had shown earlier that the yellow alkaline extract of *A. niger* spores had an adsorption spectrum similar to that of flavins, and Kitavin[9,10] observed the formation of riboflavin on media containing small amounts of mercuric chloride. In a detailed study of forty-four strains, Knobloch and Sellman[11] found twenty-two which produced yellow pigments; of these, twenty only produced pigments in the presence of reasonable quantities of magnesium, and another produced pigment with magnesium acetate as carbon source.

In an examination of some strains in this Department, some produced small amounts of pigment, both in the presence and also the absence of magnesium. Five other non-pigmented strains showed no formation of pigment when grown in the presence of sodium azide or mercuric chloride. Of these, three produced yellow pigment, two of them abundantly, when grown in submerged culture in Knobloch and Sellman's medium with 4 per cent magnesium acetate as carbon source. The pigment, which occurred as granules in the mycelial pellets, reached its intensity in three days, after which time it was liberated into the medium.

Apart from minor constituents, two main components could be distinguished by paper chromatography. One could be extracted from the medium by chloroform, and had a pale yellow fluorescence in the ultra-violet, whereas the other was insoluble in chloroform but could be extracted by butyl alcohol and had a deep blue fluorescence in ultra-violet light. Knobloch and Sellman refer to the pigment produced by their strains as 'flavin type'. The pigments here described had only end absorption with ultra-violet, showed no change of fluorescence with *p*H, were stable to acids and alkalis and were not reduced by titanous chloride or stannous chloride, from which it appears they are not flavins. Microbiological assay of the pigment solution for the presence of riboflavin indicated only traces of this substance.

It appears, therefore, that strains of the *A. niger* group possess different potentialities for pigment production. In the case of disturbance of normal metabolism by mercury poisoning or magnesium deficiency, the formation of riboflavin may be related to the necessity for increased respiratory catalyst to overcome the interference with normal metabolism.

The case of the other pigments is not yet clear, and it is of interest to determine whether they fulfil a role in respiration, or whether they are related to the brown and black pigments of the normal mycelium and conidia of this group.

The capacity for pigment production under normal conditions also varies. A strain received from Germany as *A. aureus* (Nakazawa) produced only small amounts of yellow pigment. This organism, which is known only from Nakazawa's original isolates, has been renamed *A. fœtidus* n.sp. by Thom and Raper[12] because of its penetrating actinomyces-like odour. The original specific name given by Nakazawa was due to its orange mycelium, which is deep orange in reverse. We have received an authentic culture of *A. fœtidus* n.sp., through the courtesy of Dr. Raper, which shows marked production of yellow pigment on Czapek medium. According to Thom and Raper[12], *A. fœtidus* n.sp. has maintained its characteristic odour and colour for a number of years. The isolate received from Germany retains the characteristic odour; but the colour production is very slight.

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Uridine Diphosphate Glucose: the Coenzyme of the Galactose–Glucose Phosphate Isomerization

A PREVIOUS report[1] dealt with the enzymatic conversion of galactose-1-phosphate into glucose-1-phosphate and mentioned that a thermostable factor is necessary for the reaction. This factor has now been obtained practically pure, and for reasons given below will be referred to as uridine diphosphate glucose.

The preparation of uridine diphosphate was effected by extraction of bakers' yeast with one volume of ethanol, followed by fractional precipitation with mercuric acetate, adsorption on charcoal, elution with ethanol and treatment with a cation-exchange resin.

During the last stages of purification, it was observed that the activity ran parallel with a substance showing absorption at 260 mμ. The same parallelism was observed during paper chromatography with 77 per cent ethanol. The absorption spectrum of the substance is identical with that of uridine, and shows the same changes in acid and alkali, and after treatment with bromine. For each uridine calculated from its absorption coefficient[2], the substance contains two phosphates and two nitrogens.

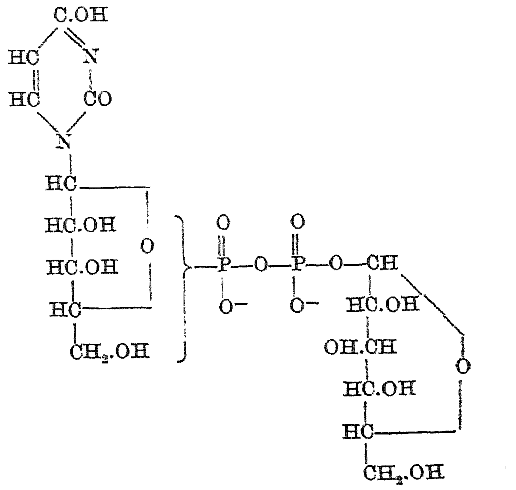
On mild acid hydrolysis, uridine diphosphate loses its coenzymatic activity and yields a molecule of a reducing sugar which was identified as glucose by selective fermentation, paper chromatography, and the carbazole reaction[3] after removing interfering substances with ion exchange resins. The rate of glucose liberation in 0·01 N acid at 100° C. is higher than that of glucose-1-phosphate (half-life-time $t_{1/2} = 0{\cdot}8$ and 3·8 min. respectively).

Intact uridine diphosphate is non-reducing, and, together with the liberation of glucose, there occurs a change in the titration curve: it has two primary phosphoric acid groups and no secondary, while removal of the glucose unmasks a secondary acid group. This indicates that the glucose must be combined at position 1 with a phosphate group. Further evidence on the linkage of glucose to phosphate was obtained by treatment of uridine diphosphate with a suspension of washed kidney particles. A substance was liberated which behaved like glucose-1-phosphate under the action of phosphoglucomutase. Oxidation of uridine diphosphate with periodate gave one molecule of formic acid and no formaldehyde, as would be expected from a glucopyranosyl residue.

The substance remaining after removal of the glucose contains two phosphate groups, one of which is 90 per cent hydrolysed in N acid at 100° C. in 15 min. After hydrolysing this labile phosphate, the reaction mixture shows two primary and two secondary acid groups. The second phosphate group is very stable, and its rate of hydrolysis was found to be nearly equal to that given by Gulland and Smith[4] for uridine-2-phosphate. However, uridine-5-phosphate cannot as yet be excluded.

The substance remaining after removal of the two phosphate groups was identified as uridine by paper chromatography. The pentose could be estimated by the orcinol reaction after bromination[5]. Further hydrolysis in 6 N hydrochloric acid for 2 hr. at 120° C. gave uracil as judged by chromatography and by its spectrum at various pH.

On the basis of this evidence, uridine diphosphate can be tentatively assigned the accompanying formula, which shows a pyrophosphate linkage and explains the facts that it has only two primary acid groups, and that one secondary acid group appears on removal of the glucose residue and another on hydrolysis of the labile phosphate. Molecular weight calculated from the dry weight and uridine content gave a value of 630, which is not too far from the theoretical value of 566.



One point is not yet clear; that is the action of alkali. Treatment with 0·1 N alkali at 100° C. destroys the activity in a few minutes. No phosphate is liberated; but there occurs a stabilization of the glucosidic linkage so that the glucose now undergoes hydrolysis at the same rate as the first phosphate group. Presumably alkali brings about a rearrangement of the molecule.

The mechanism by which uridine diphosphate accelerates the conversion of galactose into glucose will require further investigation. The fact that glucose phosphate can be recognized as a part of the coenzyme suggests that this portion may exchange with the substrate during the reaction cycle.

An interesting fact is the similarity of uridine diphosphate with the compound which Park and Johnson[6] have found to accumulate in *Staphylococcus aureus* grown in the presence of penicillin. It is not possible from their data to conclude that it is the same compound; but the resemblance is striking.

A full account of this investigation will be published elsewhere.

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Aphosphorosis in Ireland

Following Colonel Doherty's observation[1] that 'bog crook', a chronic disease of cattle which has been indigenous in certain districts of Ireland for many generations, was clinically similar to stywesiekte, Sheehy[2], in a series of controlled feeding experiments, showed that the feeding of phosphatic supplements was effective in the cure of this condition and concluded that it was aphosphorosis.

Several hundred determinations of blood inorganic phosphorus and of serum phosphatase have been carried out in this Laboratory on samples both from clinical cases of 'bog crook' and from apparently normal animals grazing on the same farms. Analyses of the herbage from the appropriate pastures have also been undertaken.

The results of this work show that a sub-clinical or incipient form as well as a clinical form of aphosphorosis exists, and that both forms are widespread in districts where there is a low phosphorus content in the pasture. In both the clinical and sub-clinical forms of this condition, there is a low level of inorganic phosphorus in the blood; only in the clinical form is there a significant rise in serum phosphatase. On phosphorus-deficient pastures both forms often co-exist, but on such pasture the sub-clinical form is always present and in many cases may be detected only by blood analysis. Sub-clinical aphosphorosis is often associated with unthriftiness, low milk-yield in dairy cows and anœstrus or œstrus with repeated failures to conceive after service. Of the clinical cases, first-calf heifers usually exhibit the severest symptoms. Mature cows and calves are not so seriously affected.

Experiments show that a change of cattle from phosphorus-deficient to phosphorus-sufficient pasture is attended by a more spectacular rise in blood inorganic phosphorus than takes place if the animals are maintained on phosphorus-deficient pasture and fed a phosphatic supplement.

It has been found that where the blood inorganic phosphorus values of members of a grazing herd are of the order of 1·0–2·0 mgm. per cent the pasture herbage contains less than 0·35 per cent P_2O_5 dry matter. Provided that cattle are not receiving supplementary feeding in addition to pasture grass, the simplest method of establishing phosphorus-deficiency in pasture is by blood analyses of the cattle grazing thereon.

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Copper-Deficiency Disease of Pear Trees

Copper has long been considered as one of the essential trace elements connected with satisfactory growth and development of most higher plants[1], and copper-deficiency in various top fruits has been established by workers in the United States, Australia, New Zealand and South Africa. The affected trees show varying amounts of leaf chlorosis, followed by the death of the terminal bud and the dieback of the vigorously growing shoots.

In September 1948, during the course of my duties as an advisory officer, my attention was directed to a very severe case of dieback of terminal shoots in vigorously growing young nursery pears. The trouble was immediately suspected to be copper deficiency, as the symptoms so closely resembled the description of the disease by workers in other countries[2–6].

During the winter season all the dead wood was pruned to induce new growth the following season. In May 1949, when the trees had made some shoot growth, and before any dieback appeared, twelve trees were sprayed with 0·1 per cent copper sulphate solution. The treated trees, by the end of August, made more than 3 ft. of healthy new wood and showed no symptoms of the disease, while the untreated trees made very slow growth and developed severe dieback in early August. The copper content of the leaves from the untreated trees was less than half that of the treated trees.

I believe this to be the first case of copper deficiency of fruit trees and its control by copper sulphate spray recorded in the British Isles. Other troubles peculiar to this nursery are suspected of being connected with the same deficiency, and work is in hand on these problems.

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Occurrence of Trombiculid Mites on Arthropods

MITES of the family Trombiculidæ include the European harvest-mites and many other notorious scrub-itch mites, as well as the vector of scrub typhus. A closely related group, the Leeuwenhoekiidæ, has also been given familial status[1], both these families having been split off from the Trombidiidæ. Trombidiid and leeuwenhoekiid adults are superficially alike; but adult trombiculids are easily distinguished by being constricted to a figure of eight. The nymphal and adult stages of all three groups are non-parasitic, so far as is known; but the larvæ collectively appear to be the most numerous of all acarine ectoparasites in the tropics. Larval trombidiids are common parasites of insects, while leeuwenhoekiid larvæ have been found parasitizing mammals, birds, reptiles, amphibia, and, more recently, arthropods[2]. That the trombiculid larvæ ('chiggers') parasitize only vertebrate hosts is, however, generally accepted as part of the definition of that family[3]. The following records of three species of trombiculids parasitizing arthropods in Malaya are therefore of considerable interest, and it is hoped that this note may stimulate more attention to this unexpected source.

Trombicula rara Walch. A few specimens of *T. rara* have been recorded: on man in Sumatra[4], possibly once in Batavia[5], and on a lizard and on man in New Guinea[6]. It has appeared occasionally on rats in recent collections in Malaya, but its principal host here appears to be a giant forest pill-millipede, provisionally identified as *Zephronia* sp. Large numbers of larvæ may be found attached in colonies to the soft integument near the anus, in a well-protected pocket. About a third of all pill-millipedes from two forest reserves near Kuala Lumpur have been found infested, occasionally with fifty to one hundred larvæ of *T. rara*. A number of nymphs have been bred by Mr. K. L. Cockings from larvæ which have fed on millipedes. An interesting point is that the specimens of *T. rara* from rats and man have been dark red, but those from the millipedes are pale ochre or yellowish in colour.

Euschöngastia [*Ascoschöngastia*] species. A single specimen of another chigger, *Euschöngastia* sp. near *E. indica* (Hirst), has also been found, together with a few *T. rara*, on this millipede.

Trombicula (or ? *Tragardhula*) sp. indet. A number of specimens of an undescribed *Trombicula* with a pentagonal scutum have been found on the common giant black Malayan scorpion, *Heterometrus longimanus* (Herbst), mostly attached under the pectens. A number of nymphs have been bred from these larvæ by Mr. Cockings. This scorpion is commonly parasitized by a few individuals of a leeuwenhoekiid, *Womersleyia* sp., while several other leeuwenhoekiid larvæ of undetermined genus have been found on a psocid, a ceratopogonid, and on two lamellicorn beetles.

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Records of the Globefish and Filefish

IN view of the paucity of records of the globefish, *Lagocephalus lagocephalus* (L.), around British coasts, it seems worth while recording the recent occurrence of a specimen at Tenby, Pembrokeshire. According to information supplied by Mr. A. L. Leach, it was found alive on September 6 in a pool on the South Sands, Tenby; its length from snout to fork of caudal fin is 14½ in. The colours of the dead specimen are as described by Day in "The Fishes of Great Britain and Ireland", but Mr. Leach states that the skin of the expansible ventral surface of the living fish appeared distinctly pinkish. Of the thirteen or fourteen British specimens of this tropical species listed by Day, nearly all were taken on the south coast; though there is one Welsh record from Amroth near Tenby, and two records from the Orkneys.

The first British example recorded—from Penzance—was described by the Welsh zoologist Thomas Pennant, who may have been responsible for the Welsh name (very appropriate to the fish when in the round, distended condition) quoted by Day—*Heulbysg crothog*, or swollen sunfish. The Tenby specimen, presented by Messrs. Lillycrop of Tenby, is now in the Zoology Department of the National Museum of Wales, its accession number being 49.373.

This seems a suitable occasion to put on record another plectognath fish very rare in British waters, *Balistes capriscus* Gmelin, the filefish or triggerfish, a specimen of which, 13¼ in. in length, was caught in a net on the foreshore at Splott, Cardiff, on October 26, 1946, and presented to the National Museum of Wales by Mr. F. Newman (accession number 45.352).

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Seismic Experiments in the Atlantic

EXPERIMENTS were carried out during August 1949 by this Department to determine, primarily, whether a method of seismic refraction shooting at sea developed during the last three years was applicable to deep water. Facilities were provided by the Air Ministry for this work to be undertaken in the Ocean Weather Ship *Weather Explorer* on one of her routine voyages. The area in which the work was undertaken lay within thirty miles of the meteorological position at lat. 53° 50′ N., long. 18° 40′ W., and in this area the depth of water was approximately 1,300 fathoms.

Depth-charges, set to fire at 900 ft. deep, were used as sources of the shock waves. These waves were detected by quartz hydrophones suspended approximately 150 ft. below sono-radio buoys which transmitted the information to the recording instruments in the ship. The charges were fired at distances up to twenty miles from the buoys, four of which were in use simultaneously spread over a line approximately three miles long.

Preliminary calculation of results from these experiments showed the presence of two interfaces below the sea-bed at depths of 7,700 ft. and 16,800 ft. In the surface layer of the bottom three determinations of the velocity of the compressional waves gave values, at different places within the area, of 6,900, 6,400 and 7,300 ft./sec., with no evidence for a continuous increase of velocity with depth. The intermediate layer showed velocities of 16,300 and 17,300 ft./sec., while the third type of rock, which extended to an indeterminate depth, gave velocities of 21,700 and 20,600 ft./sec. in two different positions. Although the velocities in a given layer showed a considerable scatter, the individual determinations had probable errors not greater than ± 3 per cent.

The low values for the velocity in the surface-layer indicate not highly consolidated marine sediments. Any estimate of the time taken for the deposition of this thickness of sediment is highly speculative and liable to be very misleading. If, however, the sediments are assumed to be of oceanic origin, and if also it is assumed that the sedimentation-rate has, throughout geological time, persisted unchanged at the present order of magnitude, then the time taken for the deposition of a thickness of 7,700 ft. is of the order of 2,000 million years.

The velocity in the layer below the sediments is such as is assigned by seismologists to the granitic layer, but it might equally represent early Palæozoic sedimentary rocks. The depth below sea-level of this layer is approximately the same as that of the continental granitic layer, but its thickness, 9,100 ft., is considerably less.

The two observations of the velocity in the third type of rock are close to the value assigned to the intermediate layer lying between the granitic and ultrabasic layers as determined from near earthquakes.

The experiments also included seismic reflexion shooting with $1\frac{1}{4}$ lb. T.N.T. charges as the source of energy. These charges were fired a few feet below the surface of the sea, and the low-frequency reflexions from the bottom were received on a hydrophone hung below the ship. The sub-bottom echoes were confused, any one record showing several apparent reflexions which, in general, were unrepeatable. There was, however, one persistent reflexion from a horizon at a depth of about 2,000 ft. below the sea-bed. This horizon does not necessarily represent a discontinuity in velocity, and this may account for the fact that it was not observed in the refraction shooting.

In the reflexion shooting the echo-time obtained from the sea-bed was consistently less than that obtained using the 14 kc./s. echo sounder. The magnitude of the difference was equivalent to 15–20 fathoms of water, and cannot be attributed to instrumental errors. Reflexions are observed where the product of velocity and density changes substantially within one wave-length, and it is therefore possible, assuming only a gradual consolidation, that the strongest reflexions could be produced at depths in the surface layer which increase with frequency.

The echo sounder records frequently showed fluctuating and at times intense echoes from depths between 10 fathoms and 40 fathoms. The discontinuity producing these shallow reflexions was often sufficiently sharp to show up the vertical motion of the ship. Measurements showed no temperature discontinuity at the reflexion depth.

The valuable assistance of Commander H. R. Wilkinson, R.N.R., and his crew in the *Weather Explorer*, to whom the success of the expedition is to a large extent attributable, is gratefully acknowledged. We also wish to acknowledge the assistance from the Air Ministry, the provision of explosives by the Admiralty, and the financial help of the Department of Scientific and Industrial Research.

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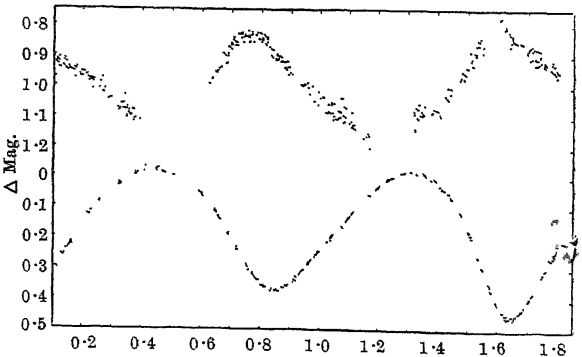
He II Emission in the Wolf-Rayet Binary Star, *CQ* Cephei

The origin of the emission lines in Wolf–Rayet stars is not entirely understood. There is supporting evidence that the emission arises in either an envelope large relative to the central star or in an envelope compactly surrounding the central star. It is obvious that if a light curve of an eclipsing binary in which one component were a Wolf–Rayet star could be obtained from a single emission line, one would have valuable data regarding the position of the emitting atoms. For if the emitting atoms were in an envelope large relative to the central star, there would be little change in the intensity of the emission as the Wolf–Rayet star was eclipsed by its companion. If the emission originated in an envelope close to the parent star, then an eclipse of the emission would be expected. An attempt was made to observe the light curve of *CQ* Cephei in He II 4686 photographically during September 1947. However, the results were not conclusive, although it was suspected from visual inspection of earlier spectrograms that the emission was not constant[1].

In September 1949 an attempt was made to obtain the light curve of He II 4686 by photo-electric means. A photo-multiplier was attached to the Cassegrain spectrograph of the 82-inch reflector of the McDonald Observatory, which served as a low-resolution monochromator. The emission line He II 4686 plus 70 A. of continuum was compared to 70 A. of continuum to the red of the emission line. The intensity of the emission line corresponded to a star of magnitude 14·5.

The resulting observations not only confirmed the suspected variation but also in addition gave a light curve of moderate precision. It was found that the intensity of the emission line He II 4686 undergoes a continuous variation. The light curve shows two maxima and two minima. When either star is eclipsed the emission is strongest; it is slightly brighter when the Wolf–Rayet star is eclipsed. At either elongation the emission is weakest; the faintest emission occurs when the Wolf–Rayet component is receding from



Light curves of *CQ* Cephei. The upper curve was obtained in radiation of He II 4686 only; the lower curve is from integrated light with an effective wave-length of approximately λ 5300. The deeper minimum of the integrated curve corresponds to that phase when the Wolf-Rayet component is eclipsed the observer. The total amplitude of the light curve is 0·4 mag. The explanation for this observed behaviour of the emission is not known; but investigation of this character on this star and other Wolf–Rayet binaries may well lead to a better understanding of Wolf–Rayet stars.

No departures from the mean curve greater than 0·02 mag. were found except on the night of October 5, 1949, when the emission was 0·15 mag. too bright. The period of *CQ* Cephei is 1·64 days.

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Nov. 12.

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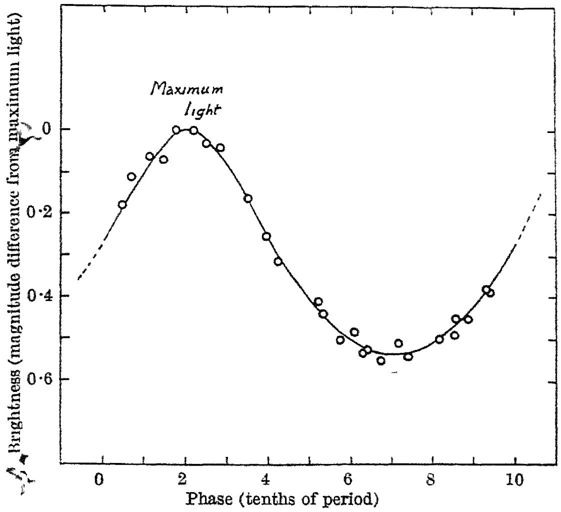
A Light Curve for the Magnetic Variable Star *HD*125248

THE A_0 star *HD*125248 (*BD* − 18°3789 Virginis) exhibits periodic changes[1] in the intensities of its absorption lines, principally those due to europium II and chromium II, with a period[2] of 9·295 days; the Eu II lines have their maximum intensity when the Cr II lines are a minimum and vice versa. Babcock[3] finds that this star has a magnetic field which varies with the same period as the absorption lines, the polar field-strength being between 7,000 to 8,000 gauss towards the earth when the Eu II lines have their greatest intensity, and of the order of 6,000 gauss of opposite polarity at the Eu II minimum. The light curve of this star was not hitherto known but has been determined at the Commonwealth Observatory in view of the remarkable interest of this star in connexion with the current theory of magnetism of rotating bodies. The results obtained with the 9-inch Oddie refractor and an *IP*21 electron multiplier are shown in the accompanying graph. The light curve is well defined, the range of the variability being 0·054 mag. with the above period.



Further details will appear later.

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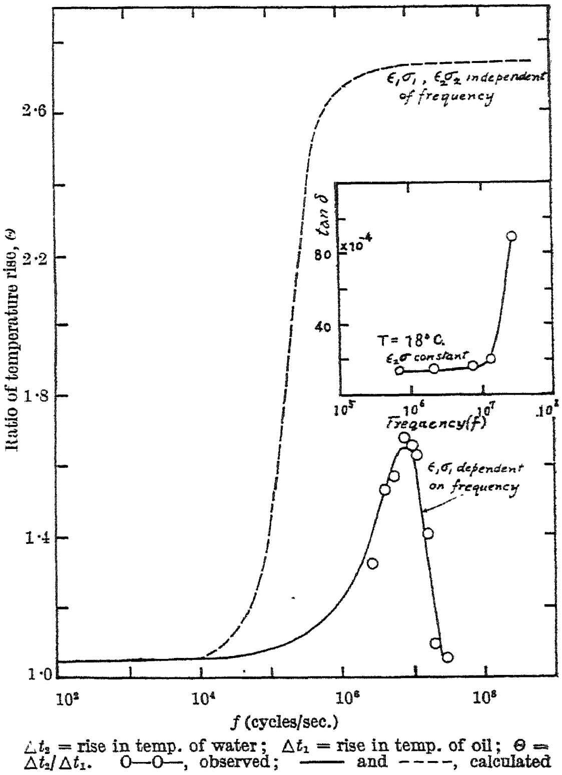
Frequency-Selective Heating at Radio Frequencies

THE differential heating of the components of a heterogeneous mixture by radio-frequency fields is a well-known fact[1,2], and the variation of the effect with frequency is often regarded as an important principle in various applications of radio- and micro-waves, for example, short-wave therapy and radio-heating. The following observations seem to establish, for the first time it is believed, the existence of a peak in the curve showing differential heating over a band of radio-frequencies.

We put a small bulb filled with water into a bath of transformer oil and kept the whole in a high-frequency field. The rises in temperature of oil and water, Δt_1 and Δt_2, were recorded constantly, and the ratio $\Delta t_2/\Delta t_1 = \Theta$ was taken after it became constant. When we plot Θ against frequency f, we find a sharp maximum, showing that water in the bulb has undergone a maximum heating at this frequency. (The experimental values are shown as small circles in the accompanying figure.)



Δt_2 = rise in temp. of water; Δt_1 = rise in temp. of oil; $\Theta = \Delta t_2/\Delta t_1$. O—O—, observed; —— and - - - -, calculated

If we denote the amounts of energy absorbed by oil and water by P_1 and P_2 respectively, it is readily shown that

$$\frac{P_2}{P_1} = \frac{1}{1+\omega^2T^2}\,\frac{9\sigma_1\sigma_2}{(2\sigma_1+\sigma_2)^2} + \frac{\omega^2T^2}{1+\omega^2T^2}\left(\frac{3\varepsilon_1}{2\varepsilon_1+\varepsilon_2}\right)^2\frac{\sigma_2}{\sigma_1}$$

$$\text{where } T = \frac{2\varepsilon_1+\varepsilon_2}{4\pi(2\sigma_1+\sigma_2)} \text{ and } R_2 \ll R_1.$$

Inserting the observed values of the dielectric constants ε_1, ε_2, and the conductivities σ_1, σ_2 of the oil and water into this equation, we calculated P_2/P_1 for a wide range of frequency, and then by the use of thermal data we estimated Θ from it. The resulting curve (full line) shows a close agreement with observed values. The maximum in the curve is associated with anomalous dispersion[3] of the oil, which begins at 13 Mc./s., as is shown by the curve of tan δ inserted in the main graph. If there is no dispersion, as in the case of liquid paraffin, the resulting curve will be like the broken line, which exhibits saturation character.

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Thermal Neutron Distribution in a Slab of Paraffin

IN a recent note[1] on the tolerance flux of thermal neutrons, P. Capron and others have described how they determined the distribution in a block of paraffin when thermal neutrons from a radium–beryllium howitzer source fall upon the free surface. They find that the neutron distribution function is given approximately by

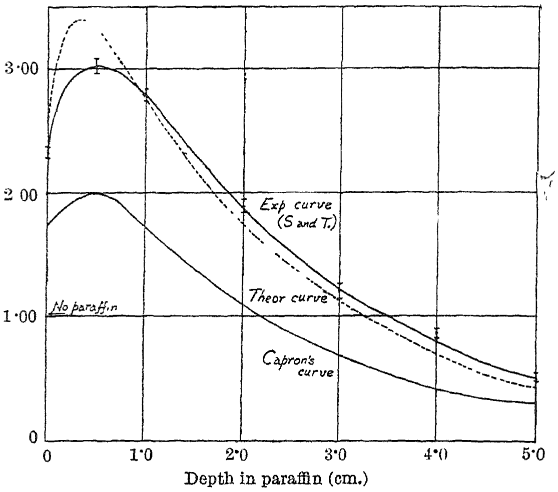
$$N = N_0 \{2\cdot55 \exp(-x/L) - \exp(-x/l)\},$$

where N_0 is the value of the incident flux of neutrons, L the diffusion-length and l the mean free path. Using this distribution curve, they then calculated the dose in soft tissue due to the γ-rays emitted from the H (n, γ) D reaction, in order to obtain the maximum tolerance flux of thermal neutrons. They found that the dose was three times greater than that calculated by Mitchell[2], who had assumed a distribution function $N_0 \exp(-x/L)$, and suggested that the maximum flux of incident neutrons should be limited to about 500 neutrons/cm.^{2}/sec.

It is possible to calculate the neutron distribution directly from the Boltzmann equation for the neutron flux. The scattering of the neutrons in the paraffin is slightly anisotropic, due to the fact that even at thermal energies the protons are not quite rigidly bound to the paraffin molecule. This anisotropy can be taken into account by taking a model in which the scattering is assumed isotropic, but the mean free path taken longer than it is in practice. The distribution curve which one then gets in the paraffin is as shown in the accompanying figure. It can be seen that the theoretical curve differs from the experimental curve as given by Capron by about 50 per cent.

For this reason the experiment was repeated using a source of thermal neutrons from a pile. This simplifies the experiment from several aspects. As the neutron flux from the pile is far greater than that from the radium–beryllium source, one can use thinner detectors in the paraffin. Detectors made of manganese foil 1 cm.^{2} in area and 5 'thousandths' thick, mounted on aluminium, were used in this experiment. Also one does not need to correct for epithermal neutrons which are present when the source consists of neutrons slowed down by paraffin. The experimental curve, as indicated in the graph, agrees with the theoretical.

The difference between this and the curve given by Capron is, in all probability, due to the fact that the detectors used by Capron were rather thick; and also there is a faulty normalization in their calculation of the incoming neutron flux. The coefficient accompanying the diffusion term in their formula for N should be about 4·5 rather than 2·55.



Thermal neutron density in paraffin for unit incident flux of neutrons. In the calculation of the theoretical curve, the values of L and σ_c (hydrogen) were taken as 2·1 cm. and 0·31 barn respectively

This would indicate that if one is to retain Mitchell's safety factor of 5, the tolerance flux of thermal neutrons should be divided by a factor 5 and not 3, as suggested by Capron, giving a tolerance flux of 300 neutrons/cm.^{2}/sec.

However, in view of the fact that the thermal distribution in paraffin is now known quite accurately, and that in soft tissue is approximately the same, it would seem that there is no need for a safety factor so high as 5. Neglecting the safety factor entirely, a tolerance flux of about 1,250/cm.^{2}/sec. for neutrons entering normally to the body, as suggested by Mitchell, could be used. This is assuming, as Mitchell did, a value of 10 for the relative biological efficiency factor for protons, and a value of 0·05 r. for the maximum permissible dose of γ-rays in 8 hours.

We wish to thank Mr. P. W. Mummery for his assistance in carrying out the experiment.

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[1] *Nature*, **163**, 129 (1949); *Bull. Acad. Roy. Belgique, Cl. Sci.* (Dec. 1948).

[2] Mitchell, *Brit. J. Rad.* (Feb. 1947).

Structure of Silk Fibroin

WHEN silk fibroin is dissolved in cupri-ethylenediamine and the solution neutralized and dialysed through a 'Cellophane' sac against running water, an aqueous solution of fibroin is obtained. Coleman and Howitt[1] have suggested that, in this water-soluble state, fibroin can exist in two forms, since at pH approximately 3·0, part is precipitated while part remains in solution. They postulated that the former part represents denatured protein in which the molecules of fibroin have an extended chain configuration, whereas that remaining in solution is in a 'renatured' form, with the molecules folded around 'proline hinges'.

By means of partition chromatography on filter paper[2], we have established the chemical identity of these denatured and renatured forms, and have also shown that both, in their turn, have an amino-acid composition identical with fibroin itself. Hydrochloric acid hydrolysates of the two fibroin fractions and of whole fibroin (degummed silk fibre) all gave identical chromatograms with regard to position, as well as size and intensity, of the amino-acid spots. The following amino-acids were shown to be present in all three: aspartic acid, glutamic acid, serine, threonine, glycine, alanine, valine, leucine, phenylalanine, tyrosine, arginine and proline.

The identity of these three forms of fibroin is demanded by the hypothesis, since the process which changes a native protein into its denatured form involves nothing more than a physical rearrangement of the molecules.

The disposition within the molecule of the constituent amino-acids of the renatured form was investigated by means of a short-duration tryptic hydrolysis of a solution of renatured fibroin. After 30 minutes of such hydrolysis, the precipitate which had formed was removed. Chromatography showed that this precipitate consisted of glycine, alanine and serine.

The chromatogram of the hydrolysis liquor, on the other hand, gave correspondingly strong spots for tyrosine, valine, leucine, arginine, phenylalanine, aspartic and glutamic acids and proline. A chromatogram obtained after hydrolysing a weight of trypsin equal to that used in this experiment showed none of these acids, as the amount of trypsin used is very small in comparison with the weight of fibroin.

Estimations of the molecular weight of the precipitate from viscosity measurements of its solution in cupri-ethylenediamine gave values around 7,000. More accurate determinations of this molecular weight, together with the range of molecular weights about this mean, are at present being attempted using an ultra-centrifuge.

The isolation from fibroin of this polypeptide of molecular weight approximately 7,000 and composed entirely of the three simplest amino-acids, glycine, alanine and serine, is of importance in the elucidation of the structure of the protein. It is now possible to construct a reasonably complete picture of the folded molecule of renatured fibroin. Between the three regions, of total residue-weight 7,000 each, lie two regions containing all those amino-acids with bulky side-chains. Using results from the most recent amino-acid analyses of fibroin, it is possible to calculate that the weight of these bulky amino-acids (together with part of the serine) per molecule totals about 10,000. Thus in the fibroin molecule of molecular weight 33,000 [1], three straight-chain sections can be envisaged with a total residue weight of 7,000 each, and containing only glycine, alanine and serine, linked by two regions of total residue weight 5,000 each and containing all the bulky amino-acids of the molecule.

These results are comparable with the X-ray results on fibroin obtained by Meyer, Fuld and Klemm[3], who showed that fibroin gave an X-ray photograph which indicated a crystalline peptide chain consisting only of glycine alternating with alanine (or serine). Coupling of the tyrosine with diazobenzenesulphonic acid left the X-ray diagram unchanged, showing that this amino-acid is in the amorphous region.

A detailed account of this work will be published elsewhere in the near future.

We wish to acknowledge the helpful discussions we have had with Dr. F. O. Howitt during the course of this work, and also the assistance of Mr. Trevor Hamlin in much of the experimental work.

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[2] Consden, R., Gordon, A. H., and Martin, A. J. P., *Biochem. J.*, **38**, 224 (1944).

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A Relay Machine for the Demonstration of Symbolic Logic

EIGHTY years ago, Jevons, then professor of logic at Owens College (now the University of Manchester), built a machine which could perform logical inference by mechanical means[1]. Other similar machines have been built since then. With the present interest in electrical and electronic computing machines, it seemed worth while to construct a logical machine using modern electrical methods, at the same time basing it on the present-day logical technique of truth tables rather more explicitly than had been done by Jevons.

A small machine incorporating these ideas has now been built at the Instrument Department of Ferranti, Ltd. The machine deals with the logical relations between three propositions or 'variables' A, B, C. These variables and their 'functions' (relations) are represented in the form of binary numbers (essentially an abbreviated form of their Boolean expansions) which are stored in electromagnetic relays, 'on' (1) standing for truth, 'off' (0) for falsehood. The state of each relay is indicated by a lamp.

Five stores, each containing eight relays, are provided. Two of these (U, V) accept the initial propositions A, B, C and their negatives. A third store S accepts the result of a logical operation performed on the contents of U and V; these operations, which can be selected by corresponding switches, are conjunction ('and'), disjunction ('or'), implication ('if, then'), equivalence ('if and only if') and negation ('not').

The contents of S can be transferred to two auxiliary stores and from there back to U and V so that further operations can be performed on them.

A tautological relation is indicated by the lighting up of all the eight lamps of store S.

A function $F(A, B, C)$ implies, in general, a number of functions $R(A, B)$ of two variables. It is then pertinent to ask for that particular function $G(A, B)$ among them, which implies all the others. This 'optimum implicate' can be found by a process closely analogous to the projection of a three-dimensional pattern on a two-dimensional plane. Facilities for carrying out this process are provided in the machine.

It is not to be expected that a machine of this small size will be able to solve logical problems which could not be done with pencil and paper, but it is hoped that this machine may prove to be of value in the teaching of symbolic logic, and that it will stimulate the interest of students in what otherwise tends to become a rather dull subject, and impress on them the mechanical nature of logical operations.

Acknowledgments are due to Ferranti, Ltd., for providing facilities for the construction of the machine and to Mr. R. Naylor for his work in assembling it. A fuller description of the machine and the underlying logical methods will be published elsewhere.

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[1] Jevons, W. Stanley, *Phil. Trans. Roy. Soc.* **160**, 497 (1870).

Wetting and Contact-Angle Hysteresis

THE study of contact angles and contact-angle hysteresis in the region of low contact angles is not easy owing to difficulties of technique. The contact angle, θ, is given by

$$\cos\theta = \frac{\gamma_{SA} - \gamma_{SL}}{\gamma_{LA}}, \qquad (1)$$

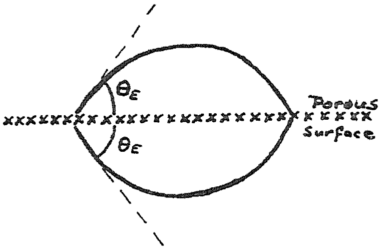
where θ is the contact angle measured in the liquid and γ_{SA}, γ_{SL} and γ_{LA} are the surface free energies per unit area of the solid–air, solid–liquid and liquid–air interfaces respectively.

In any practical case using a pure liquid, γ_{SA} is not the true value, as the solid surface is modified by adsorption of the vapour of the liquid; and so in any contact-angle measurements it is the effective or modified value of γ_{SA} which is of importance[1-3]. If a wetting agent is used, then all the interfacial energies may be modified by adsorption of the wetting agent. The interfacial energies considered in equation (1), therefore, will be the effective values. In general, equation (1) may be written:

$$\gamma_{SA} - \gamma_{SL} = k\gamma_{LA}, \qquad (2)$$

and wetting of a solid by a liquid is considered to occur when $k \geqslant 1$ [4,5]. The direct measurement of k for such values is not possible as no finite contact angle exists.

Measurements of k can, however, be made using an extension of the theory of the water repellency of porous surfaces[6]. If we consider a porous surface, then any liquid with a positive value of k will penetrate to some degree into the surface. If we have a thin porous surface, then a drop of liquid with $k \geqslant 1$ will penetrate through the surface and, provided the porosity is sufficiently high and the drop sufficiently small, it will orient itself symmetrically on both sides of the surface, as is shown diagrammatically in the figure. In such a position the drop is completely stable and no spreading occurs along the solid portions of the porous surface even if they are continuous. That no spreading occurs along a fine filament in contact with a drop large in comparison with the filament diameter can readily be shown by suspending a drop of, say, liquid paraffin on a glass filament, when it will remain indefinitely if evaporation is eliminated. Spreading of a spherical drop over a cylindrical surface can only take place when the cylinder radius is greater than half the radius of the drop, even though k is equal to unity. The contact angle, θ_E, of the diagram can be shown to be given by



Liquid drop on thin porous surface

$$\cos\theta_E = \frac{f}{2}k, \qquad (3)$$

where f is the area of solid–air interface per unit geometrical area of the porous surface. Therefore, as f and θ_E can be measured, k can be determined.

In no case was a value of $k > 1$ found and, using such liquids as benzene, aniline, diethyl phthalate, on fine nickel and copper structures[7], the values of θ_E were found to be identical for all the organic liquids tested and were the same for expanding and contracting drops. Further, a determination of f showed that k was unity in all these cases. It was interesting to note that when a wetting agent was added to water, the maximum value of k was again unity, and in this case also no contact-angle hysteresis was observable.

These results indicate that the liquid in such cases is, in fact, spreading over an adsorbed layer of itself on the solid, and that the energy changes on spreading are zero or negligible. That no hysteresis occurs indicates complete coverage of the solid surface by a layer of adsorbed molecules of the liquid. This is, of course, to be expected, since if the true value of k is greater than 1, then the liquid would have more affinity for the solid than for itself. In such a case complete coverage would take place.

A fuller account of this work, together with its application to the study of surface-active agents in wetting and detergency, will be presented in due course.

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Induced Molecular Vibrational and Rotational Absorption

IN view of recent advances in the technique of absorption measurements in the infra-red and micro-wave regions, I wish to direct attention to a method by which transitions normally forbidden in such absorption might be made to appear. The method is applicable, for example, to the vibration and rotation of homonuclear diatomic molecules and to the breathing mode of vibration of molecules like

CH_4; and, in general, to all transitions that are permitted in the Raman effect.

Consider first vibrational transitions. The appearance of a fundamental vibration frequency in the Raman spectrum is due to a change of polarizability with nuclear vibration co-ordinate. Therefore, if we apply an electrostatic field to the molecule, there must be a change of the induced electric dipole moment during the vibration in question. The condition for the appearance of the frequency in infra-red absorption is thus realized. In the induced effect, the quantity $E\alpha'$ (where E is the applied field-strength and α' is the derived polarizability) will play the same part as does μ' (the rate of change of permanent dipole moment with nuclear co-ordinate) in ordinary dipole absorption. From absorption measurements in the infra-red, the value of μ' for HCl has been found[1] to be $0{\cdot}086e$ (where e is electronic charge). Recently Herzberg[2] has succeeded in observing the infra-red quadrupole absorption of H_2, the strength of which is calculated to be only $8{\cdot}1 \times 10^{-9}$ of that for the dipole absorption of HCl. Considering now the induced effect for the breathing mode of CH_4, the value $\alpha' = 7{\cdot}7 \times 10^{-16}$ cm.^{2} has been deduced[3] from the isotope effect upon refractivity. Neglecting the small influence of the amplitude factor of the transition moment, we hence calculate that the applied field-strength required to induce for this mode of CH_4 an absorption as strong as that observed by Herzberg would be about 2×10^3 volts/cm. In practice, a value perhaps ten times greater than this might be used without exceeding the dielectric strength of the gas. This would induce an absorption a hundred times stronger. It appears that the induced effect should be well within the limits of observation.

It is of importance to note that the applied field could be given a definite periodicity, so that the induced effect would be modulated and high sensitivity of detection could be achieved by the use of selective amplification.

In the breathing mode of vibration of CH_4, the polarizability remains isotropic and the induced moment independent of molecular orientation. Rotational transitions would thus be forbidden: only the Q-branch would be observed. For a non-isotropic molecule like H_2, the induced vibrational absorption would (like the Raman effect) be associated with the rotational selection rule $\Delta J = 0, \pm 2$.

Coming now to pure rotational absorption, it would be an important advance if, by the application of the induced absorption effect, the powerful and precise methods of micro-wave spectroscopy could be extended to the study of non-polar molecules. Present technique is reported[4] to permit the detection of an attenuation coefficient of about 10^{-9} cm.$^{-1}$. Taking $\nu = 1$ cm.$^{-1}$, $J = 1$, $T = 200$ and the line breadth constant $(\Delta\nu)_1 = 10$ mc., we calculate that the corresponding dipole moment is of the order of 10^{-3} D. In the induced absorption for a non-polar linear molecule the effective dipole moment may be set roughly equal to $E(A - B)$, where A and B are respectively the polarizabilities along and at right angles to the axis of the molecule. The difference $(A - B)$ can be determined from the refractivity and the degree of depolarization of Rayleigh scattering, and will be of the order of 10^{-24} cm.^{3}. Hence we calculate that the applied field-strength required in order to give a strength of induced absorption just detectable with the present sensitivity would be of e order of 10^5 volts/cm. It is estimated[4] that an attenuation coefficient as low as about 10^{-11} cm.$^{-1}$ could be detected with improved technique, in which case the applied field-strength would have to be of the order of 10^4 volts/cm. It thus appears that with the strongest practicable fields the intensity of the induced pure rotational absorption would probably be near the limits of experimental detection. The induced absorption would, of course, show the Stark effect.

Since preparing this letter, my notice has been directed for the first time to a paper published in 1932 by Condon[5], in which the effect of an applied electrostatic field in inducing vibrational absorption was similarly considered. Despite the notable advances of technique achieved since that date in the infra-red and more especially in the micro-wave region, the possibilities of induced absorption have not (so far as I am aware) been the subject of experimental investigation.

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[1] Bartolome E., *Z physik Chem.*, B, **23**, 131 (1933).

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Thermo-osmosis of Gases Through a Membrane

DENBIGH[1] has recently reported the discovery of a thermo-osmosis phenomenon for carbon dioxide and hydrogen through rubber diaphragms. When a temperature-difference is maintained across the diaphragm, a flow of carbon dioxide occurs from the cold to the warm side until, in the absence of an external circuit, a stationary pressure difference is built up sufficient to prevent further flow. The effect with hydrogen is in the opposite direction and is only about 30 per cent of that with carbon dioxide. The data satisfy the equation:

$$\log \frac{p_1}{p_2} = \frac{Q^*}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right). \qquad (1)$$

Denbigh suggested that the phenomenon might be due to the effect of temperature on the solubility of the gas in the membrane. It is the purpose of this note to show that, indeed, the data can be quantitatively accounted for on this basis alone, the possibility of a thermal diffusion process within the membrane being neglected.

Within the pressure-range studied, the solubility of the gas in rubber follows Henry's law. We may write

$$c = kp, \qquad (2)$$

where c is the concentration of dissolved gas, p the gas pressure, and k, the solubility constant, a function of temperature. If the pressures on the two sides of a membrane are maintained equal, the existence of a temperature-difference will, in general, result in different values of k, and therefore of c, at the two surfaces of the membrane. The difference in values of c constitutes a driving force for the gas, and gas will flow continuously if an external circuit is provided. If there is no external circuit, gas will continue to flow until the values of c on the two sides are equalized. From (2) we have $c_1 = k_1p_1$ and

$c_2 = k_2p_2$ for the two sides of the diaphragm. The condition for the establishment of a stationary pressure difference is $c_1 = c_2$. This implies $k_1p_1 = k_2p_2$, or

$$\log \frac{p_1}{p_2} = \log \frac{k_2}{k_1}. \tag{3}$$

Now to a good approximation k depends exponentially on temperature :

$$k = k_0 \exp - Q^*/RT, \tag{4}$$

where Q^* is related to the heat of solution. For temperatures T_1 and T_2,

$$\log \frac{k_2}{k_1} = \frac{Q^*}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right). \tag{5}$$

Substitution of (5) in (3) results in (1), the equation given by Denbigh.

The values of Q^* for carbon dioxide and hydrogen may be obtained from the data of van Amerongen[2] on various rubbers. Q^* for carbon dioxide in natural rubber is about − 2,700 cal./mole, while Q^* for hydrogen is about + 1,000 cal./mole. It should be noted that the signs are in the right direction, carbon dioxide showing a flow from cold to warm and hydrogen from warm to cold, and that the value for hydrogen is only about a third that for carbon dioxide, in agreement with observation. The value of Q^* for carbon dioxide given by Denbigh, − 309 cal./mole, is low, as Denbigh points out, because the temperatures measured were not the true surface temperatures.

If the explanation given is correct, it is clear that every gas the solubility of which in the membrane decreases with increasing temperature will show a thermo-osmotic flow from cold to warm, and conversely for gases the solubilities of which increase with increasing temperature.

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[1] Denbigh, *Nature*, **163**, 60 (1949).

[2] van Amerongen, *J. App. Phys.*, **17**, 972 (1946).

THE temperature coefficient of solubility is undoubtedly *one* of the components of the thermo-osmosis effect. However, Dr. S. Weller is in error when he says "the data can be quantitatively accounted for on this basis alone . . ." To do this it would have to be shown that the observed values of Q^* are *equal* to the known values of the heats of solution. On the other hand, if thermal diffusion is an appreciable second component, this equality would not be obtained. The testing of these possibilities is the object of our experiments and has not yet been achieved on account of difficulties in measuring the surface temperatures.

The treatment put forward by Dr. Weller was known to us at the time of the original communication and depends on the supposition $c_1 = c_2$, that is, that there is no concentration gradient of dissolved gas. It is only when this occurs that the theory based on equilibrium thermodynamics and Henry's law is approximately correct. In the more general treatment it is necessary to allow for the possibility of a finite thermal diffusion within the membrane. This can be done on the basis of Thomson's hypothesis[1] or by the use of Onsager's theorem. This results in an expression of the same *form* as quoted by Dr. Weller and as given in the original communication. The quantity Q^* is the 'heat of transport' across the membrane and reduces to the heat of solution only in the limiting case of no thermal diffusion[2]. Some preliminary results on nitrogen indicate, however, that the latter effect may be appreciable. This gas passes through the rubber membrane from cold to warm. On the other hand, the temperature coefficient of its solubility is either zero[3], or has a very small positive value[4] which would indicate a flow in the reverse direction to that observed. However, these results are not yet quite certain, as the nitrogen was not of the highest purity.

It may be mentioned that whereas the above is concerned with diffusion normal to an interface, we are now extending observations to the case of thermal diffusion in surface layers on solids in a direction *parallel* to the interface, with possible applications in adsorption, catalysis, sintering, etc.

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[1] Eastman, *J. Amer. Chem. Soc.*, **48**, 1482 (1926).

[2] Wirtz (*Z. Naturforsch.*, **3a**, 380 (1948)) has reached similar conclusions from a kinetic argument.

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Relativistic Variation of Rest Mass

WE propose to show that the constancy of rest mass during non-uniform movement is by no means a general feature of restricted relativity. It applies only to a special, though very important, type of a model, namely, the point charge model.

It is sufficient for our purpose to write the dynamical laws in the form

$$\frac{\partial T_i{}^k}{\partial x_k} = - F_{ik} \cdot s^k, \tag{1}$$

with

$$T_i{}^k = \mu_0 c^2 \cdot u_i \cdot u^k \, ; \quad s^k = \rho_0 \cdot w^k,$$

F_{ik} being the electromagnetic field tensor, μ_0 and ρ_0 the rest densities of mass and charge distributions and u^k and w^k the velocity four-vectors of mass and charge convection. Then we obtain from (1) :

$$\mu_0 c^2 \cdot \frac{du_i}{ds} + \frac{\partial \mu_0 c^2 u^k}{\partial x_k} u_i = - \rho_0 F_{ik} w^k, \tag{2}$$

$$\frac{\partial \mu_0 c^2 u^k}{\partial x_k} = - \rho_0 F_{ik} u^i \cdot w^k. \tag{3}$$

(3) determines the rest mass balance. In the case of point charges, $u^k = w^k$, (3) becomes a conservation law. In general, however, no conservation of rest mass takes place.

We can immediately apply (2) and (3) to Ampère's experiment (attraction between two parallel currents), where the direction of force and of current do not coincide. We obtain from (2) and (3) that energy is conserved

$$\frac{d}{dt}\left(\frac{mc^2}{\sqrt{1-u^2/c^2}}\right) = 0; \qquad (4)$$

but both m and $\mathbf{u}$ vary during the motion. Of course, in this case the variation of total mass m can be attributed to the variation of the kinetic energy of internal movements (included in the total mass), for example, to a decrease of kinetic energy of supposed point charges which form the current.

(4) applies equally well, if we consider the interaction between two small circuits (magnetic dipole model) of magnetic moment M and μ. Considering M fixed and μ moving towards it from rest at infinite distance, we find from (2) and (3):

$$m = m_\infty \sqrt{1 - 2\,\frac{\mathbf{uH}}{m_\infty c^2}} \cong m_\infty - \frac{\mathbf{uH}}{m c_0{}^2}. \qquad (5)$$

(5) represents the mass defect of our system due to the orientation of the magnetic moment in the external field. Schwinger[1] has found, in the case of Dirac's electron, which is much closer to the point-charge model, a considerably (2×137) smaller value for the mass defect.

Generalizing our results to the case of an arbitrary static field, we find that this field does not contribute directly to the energy of the system by

$$\frac{1}{8\pi}\int (E^2 + H^2)\,.\,d\tau,$$

but indirectly by its contribution to the mass of the system

$$\frac{1}{8\pi}\int (E^2 - H^2)\,.\,d\tau. \qquad (6)$$

At least a part of the mass of a charged particle being distributed according to (6), a charged particle cannot be represented rigorously by a point-charge model. In the mechanical representation

$$p_0 - \frac{\mathbf{v}}{c}\,.\,\mathbf{p} = \sqrt{1 - \frac{v^2}{c^2}}\,.\,mc; \qquad (7)$$

it is the right-hand side which corresponds, partly or entirely, to (6).

The fact that rest mass depends on fields is therefore a general feature of relativistic dynamics. It explains slight mass variations of elementary particles, mass defects of compound systems, and it can lead to an understanding of the much more drastic mass changes which we witness if pairs of electrons are created or annihilated.

GUIDO BECK

Córdoba Observatory.
July 29.

[1] Schwinger, J., *Phys. Rev.*, **73**, 416 (1948).

Corrosion Resistance of Analytical Weights

THE thinly plated or plain polished brass weights commonly used in laboratories are too frequently unreliable, even under good atmospheric conditions. Weights of 80 per cent nickel – 20 per cent chromium non-magnetic alloy, first suggested by the National Physical Laboratory, though more expensive than plated weights, were known to be very stable in mass under good atmospheric conditions, and have been commercially available for ten years. More recently, following tests made at the National Physical Laboratory on the magnetic properties of various stainless steels[1], the 25 per cent chromium – 20 per cent nickel type has also been recommended, and weights of this material are now available. However, little information has hitherto been available on the stability of weights in the contaminated atmosphere of chemical laboratories, though Ward[2] made high claims for chromium-plated weights, partly on his own experience and partly on the basis of observations by Manley[3] on the removable film formed on weights during storage under good conditions.

The National Physical Laboratory has now completed some comprehensive comparative tests of weights of all these materials, giving special attention to the effect of thickness of plating on the resistance to corrosion of brass weights plated with platinum and rhodium (with and without underlying silver), and chromium (over nickel). With the view of obtaining results quickly, a representative selection of 100-gm. weights was exposed for two three-month periods over the working bench in each of five chemical laboratories, the chemical content of the atmospheres of which varied widely both in quality and quantity. The weights were exposed freely to the atmosphere, but were well shielded from dust.

The main results, judged principally from changes in mass, are:

(1) The most resistant weights were of highly polished 25 per cent chromium – 20 per cent nickel stainless steel.

(2) There was little to choose between weights of less highly polished 25 per cent chromium – 20 per cent nickel stainless steel, 80 per cent nickel – 20 per cent chromium nickel-chromium and plated weights having a nominal thickness of plating of about 0·015 mm. or more. Weights coated with merely a 'flash' of platinum, or rhodium, were not very much superior to weights of plain polished brass, the changes of which were more than ten times those of the best weights.

(3) Among the plated weights, the appearance of those plated with chromium deteriorated the least; but any superiority in the stability in mass of these weights over other weights having the same total thickness of plating was only slight.

(4) The experience of the National Physical Laboratory that some good-quality plated weights show considerable changes in mass, even under good atmospheric conditions, was confirmed. The mechanism of these changes is not yet clear.

(5) No correlation was found between the different chemical characteristics of the individual laboratories and the changes in the particular weights exposed in them.

An account of this investigation is being prepared for publication elsewhere.

P. H. BIGG
F. H. BURCH

National Physical Laboratory,
Teddington, Middlesex.
Nov. 9.

[1] Gould, F. A., *J. Sci. Instr.*, **23**, 124 (1946).

[2] Ward, A. F. H., *Chem. and Indust.*, 393 (1945).

[3] Manley, J. J., *Phil. Mag.*, **16**, (7), 489 (1933).

Dissociation Constants and Dissociation Velocities of Substituted Pyruvic Acids

IT has been shown[1] that weak acids are very often reduced polarographically in two steps. The more positive step belongs to the undissociated acid, the more negative to the acid ion. The total height of these two steps remains constant; but their ratio is changed in a characteristic way with the pH of the solution. If we plot this ratio against the pH, we obtain a curve which resembles very closely a dissociation curve. The pK of this dissociation curve is, however, generally shifted several pH units to higher values in comparison with the true acidity of the particular acid.

This shift is due[1] to the rapid recombination of the acid ions with protons in the neighbourhood of the dropping electrode. The mathematical theory developed[1,2,3] introduced simplifications, but accounted for all the facts. Later a rigorous formulation was given, and it is possible[4] to calculate the velocity constant of the recombination reaction accurately from the shift of the pK value.

In this calculation it was assumed that the recombination is due solely to the reaction between acid ions Ac' and free hydrogen ions. Therefore, for the calculation of the effective velocity constant k_{ef}, the simplified form of the reaction velocity expression $k_{\text{ef}}\,[Ac']\,[\text{H}^+]$ is used instead of the more accurate

$$k_{\text{H}^+}\,[Ac']\,[\text{H}^+] + k_{\text{H}_2\text{O}}\,[Ac']\,[\text{H}_2\text{O}] + k_{ac\text{H}}\,[Ac']\,[ac\text{H}$$

that is,

$$k_{\text{ef}}[\text{H}^+] = k_{\text{H}^+}\,[\text{H}^+] + k_{\text{H}_2\text{O}}\,[\text{H}_2\text{O}] + k_{ac\text{H}}\,[ac\text{H}],$$

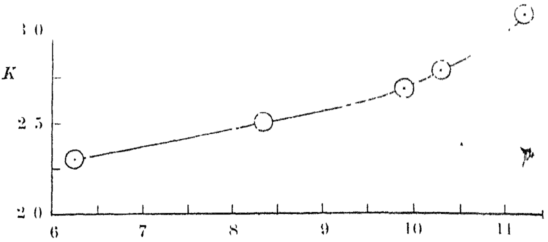
where $ac\text{H}$ represents the acid of the buffer solution.

We can, however, compare k_{ef} for different acids if we use the same buffer solution. Also changes in buffer concentration have only a very small influence. In view of the importance of the relationship between the dissociation constants and dissociation velocities of acids for the theory of acid-base catalysis and for the interpretation of the Brønsted equation, we have determined the dissociation constants and k_{ef} of a number of substituted pyruvic acids. The results are given in the accompanying table. The buffer solution used was the Britton–Robinson[5] universal buffer.

Acid	pK	pK_p	t	log k_{ef}
3,4 Dimethoxyphenyl-pyruvic	3·10	7·6	2·90	11·24
Phenylpyruvic	2·68	6·72	2·93	9·89
Trimethylpyruvic	2·30	4·70	2·90	6 24
Pyruvic	2·50	5·85	2·97	8·33
Diphenylpyruvic	2·78	6 98	3·00	10·30

t, drop time of the mercury electrode; pK, real pK determined by potentiometric titration; pK_p, apparent polarographic dissociation constant which gives the pH at which the positive and negative polarographic waves have the same height; log k_{ef} was obtained by the Koutecky and Brdicka calculation, namely, $\log k_{\text{ef}} = 2(pK_p + \frac{1}{2}\log y_1) - pK - \log t$; y_1 is a tabulated function (ref. 4).

Plotting log k_{ef} against pK, it is found that the values lie on a smooth curve which is nearly a straight line (see graph). Several acids not belonging to the pyruvic acid series have been found to give pK and k_{ef} values which do not lie on this curve.



We hope to investigate other series of homologues and to eliminate completely the influence of the buffer by systematic variation of buffer concentration and extrapolation to zero.

E. G. CLAIR
K. WIESNER

Chemistry Department,
University of New Brunswick,
Fredericton, N.B.
Aug. 18.

[1] Brdicka, R., and Wiesner, K., *Coll*., **12**, 138 (1947); *Chem. listy*, **40**, 66 (1946).

[2] Wiesner, K., *Chem. listy*, **41**, 6 (1947).

[3] Brdicka, R., *Coll.*, **12**, 212 (1947).

[4] Koutecky and Brdicka, *Coll.*, **12**, 338 (1947).

[5] Britton, H. T. S., "Hydrogen Ions", 225 (1932).

Oxides of Praseodymium

THE two oxides of praseodymium described in the literature are the light green sesquioxide and the dark brown 'air-ignited' oxide. It is generally agreed that the composition of the latter approximates to Pr_6O_{11}. Prandtl and his school[1] claim that praseodymium can exhibit a higher valency of 5, and on this basis designate the air-ignited oxide as $2Pr_2O_3.Pr_2O_5$. Marsh[2] affirms, however, that praseodymium possesses a maximum valency of 4, a conclusion which is well supported by the work of Zintl and Morawietz[3], and represents Pr_6O_{11} as the double oxide, $4PrO_2.Pr_2O_3$.

Since Pr_2O_3 is derived from the lower of the two valence states of praseodymium, it might be expected that the potential quadrivalency (on energetic grounds quadrivalency appears more likely than pentavalency) of this metal will favour the formation of a non-stoichiometric phase with a range of composition on the oxygen-rich side of the ideal formula. According to Wilson's[4] theory of semi-conductors, these oxides would be deficit conductors showing positive-hole conduction. Conversely, PrO_2, if partly denuded of oxygen, would give rise to oxides which are on the metal-rich side of the ideal formula and are electron conductors.

The present communication reports experiments which indicate that this is indeed the case, and that praseodymium forms a series of non-stoichiometric oxides in the range $PrO_{1\cdot5} - PrO_{2\cdot0}$. On this basis the air-ignited (that is, ignited in a partial pressure of 150 mm. oxygen) oxide is non-stoichiometric in character and is properly represented by the formula $PrO_{1\cdot83}$. No particular significance should be ascribed to the representation Pr_6O_{11}.

Tensiometric measurements on this oxide system, in conjunction with X-ray diffraction patterns of oxides $PrO_{1\cdot500}$, $PrO_{1\cdot585}$, $PrO_{1\cdot658}$, $PrO_{1\cdot710}$ and $PrO_{1\cdot833}$, indicate that two oxide phases exist, one cubic and one hexagonal. The former is derived from the fluorite type, PrO_2, the latter from the hexagonal type *A*, Pr_2O_3 [5]. These measurements indicate that the range of stability of the intermediate phases is as shown in the accompanying scheme. The estimated compositions of the phase boundaries are uncertain to about 2 per cent.

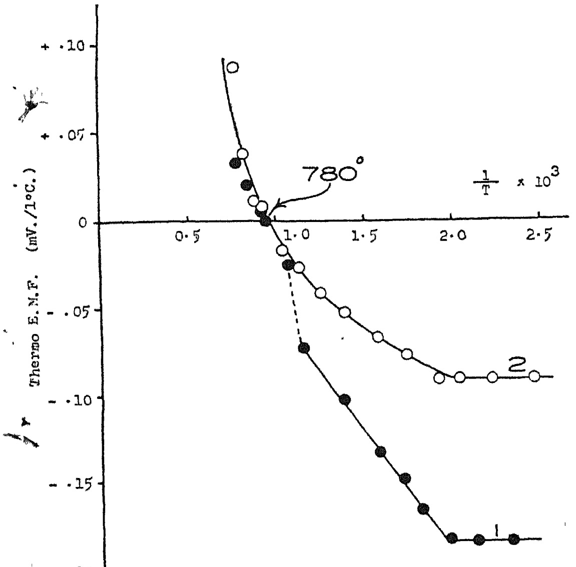
	Hexagonal Type *A* plus oxygen		Two-phase region		*Cubic* Fluorite minus oxygen	
$PrO_{1\cdot50}$		$PrO_{1\cdot55}$		$PrO_{1\cdot75}$		$PrO_{2\cdot0}$

Thermo-electric measurements supported this phase diagram. Thus it was found that oxides with the hexagonal type *A* structure displayed positive thermo-potentials, confirming that type *A* $PrO_{1\cdot50}$ can accommodate small amounts of additional oxygen in the lattice. On the other hand, the air-ignited oxide, $PrO_{1\cdot83}$, exhibited negative thermo-potentials, showing that it is effectively PrO_2 deficient in oxygen, and *not* $PrO_{1\cdot50}$ with excess oxygen.

In the course of these measurements, it was found that type *A* oxides exhibited much larger thermo-potentials than the air-ignited oxide. It might be expected, therefore, that the two-phase region will show positive thermo-potentials characteristic of the type *A* phase, and that in passing from the defect fluorite-phase to the two-phase region, the thermo-electromotive force of a typical couple, metal/air-ignited oxide/metal, will change sign.

Experiments were made in which the electromotive force of couples of the type chromel/$PrO_{1\cdot83}$/chromel was measured in air over a temperature range 200–1,100° C., the air-ignited oxide being progressively denuded of oxygen as the temperature increased. The accompanying graph shows the temperature variation of the thermo-electromotive force of two such couples.

It is seen that below 780° C. the direction of the thermo-electromotive force indicates electron conduction. It is evident that in this region, like other properties associated with semi-conduction, it is not a material constant, but is variable from specimen to specimen and dependent on past history. At 780° C. it is zero for both specimens, and above this temperature changes to positive values.



Thermo-electromotive force–1/*T* curves for air-ignited material. Curve 1, plate *A*3; curve 2, plate *A*5

It should be pointed out, however, that an explanation of this effect can be found which does not depend upon a phase transition. On the Wilson model of a semi-conductor, it is reasonable to expect that there is a limiting concentration of electrons in the conduction band, above which electrons will assume the nature of positive holes. In air-ignited praseodymia, there are effectively two electrons shared between every $6Pr^{4+}$ cations. This relatively high electron concentration will increase with evaporation of oxygen out of the lattice, and it may be that at 780° C. the limiting electron concentration is reached, when the conduction mechanism will change from one which is electronic to one which is positive-hole in nature. Support for this explanation is given by the small values of the thermo-electromotive forces recorded, which indicate that 'metal-like' conditions exist in the semi-conductor.

I am indebted to Dr. J. S. Anderson for valuable discussion and advice during the course of this work.

R. L. MARTIN

Chemistry Department,
University of Melbourne,
Carlton, N.3.
Sept. 19.

[1] Prandtl, *Z. anorg. Chem.*, **149**, 235 (1925); **238**, 225 (1938).
[2] Marsh, *J. Chem. Soc.*, **15** (1946).
[3] Zintl and Morawietz, *Z. anorg. Chem.*, **245**, 26 (1940).
[4] Wilson, *Proc. Roy. Soc.*, A, **133**, 458 (1931); **134**, 277 (1932).
[5] Pauling, *Z. Krist.*, **69**, 415 (1928).

Systems of Mutually Immiscible Liquid Layers

JÄNECKE[1] and Lester Smith[2] have described systems of four non-metallic liquid layers in equilibrium. Hildebrand[3] has recently obtained a system of five non-metallic layers (heptane, aniline, water, perfluorokerosene and supercooled phosphorus) and two metallic layers (gallium and mercury). A more easily obtained (and safer) system with five stable non-metallic layers is described below.

Such of the fatty alcohols as are not completely miscible with water are, when perfectly dry, miscible with liquid paraffin; but *iso*butyl (or amyl) alcohol, liquid paraffin, and water together form a three-phase system. Methylene iodide and mercury, added to this, form two further phases.

If the water is replaced by mutually immiscible solutions of ammonia and potassium carbonate (the organic layers being first shaken with excess of the former to saturate them with ammonia), a system of six liquid phases results. These are, from the top downwards: (i) ammonia solution; (ii) *iso*butyl alcohol; (iii) liquid paraffin; (iv) potassium carbonate solution; (v) methylene iodide; (vi) mercury. Gallium would form a further layer above the mercury.

After shaking, the layers separate within a minute. After standing for about a month in a sealed tube at room temperature, the ammonia sinks to third place and then unites with the carbonate layer. This is due to a reaction involving the methylene iodide.

If the water in Hildebrand's system were replaced by solutions of potassium carbonate and ammonia (the other layers having first been saturated with the latter), a system of eight liquid phases would result.

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R. E. PATTLE

Chemical Defence Experimental Establishment.
Sept. 23.

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[1] Jänecke, *Z. Electrochem.*, **33**, 518 (1927).

[2] Lester Smith, *Nature*, **127**, 91 (1931).

[3] Hildebrand, *J. Phys and Colloid Chem.*, **53**, 944 (1949).

South African Stone Age Terminology

IN commenting on recent research in South Africa, Mr. Miles Burkitt[1] directs attention to the recognition of the presence of the Magosian Culture "from British Somaliland to the Cape", and adds : "one can only hope that all the many Magosian discoveries in Africa are really Magosian. . . . There is a danger of over-simplification ; a culture name can easily become a sort of dustbin into which many different discoveries are thrown."

Anyone handling newly discovered archæological material has to decide whether that material should be assigned to an already recognized culture, or whether it demands a new classification with a new name. Errors of judgment in one direction will lead to the confusion which Mr. Burkitt deplores ; errors in the other direction lead to a multiplicity of terms, often half-understood by co-workers, and the separation of things which should not be separated. Both types of error will lead us astray, but over-analysis will take us farther from the truth than will over-synthesis, and is more difficult to correct in the light of later knowledge.

The discovery of industries in South Africa made up of final Middle Stone Age forms in association with Wilton forms was not unexpected, since they fill an obvious hiatus between the Middle Stone Age and the microlithic industries of the Later Stone Age. Since the term 'Magosian' had been coined by Mr. Burkitt for a culture in Uganda which presented precisely the same combination of Middle Stone Age and Wilton forms, it would have been difficult to justify the coining of a new name for the South African discoveries. There may be, and probably are, differences between the Magosian of Magosi and the Magosian of South Africa, for which reason we have meticulously used the term 'South African Magosian' and not simply 'Magosian' for the South African occurrences. The qualifying regional prefix is essential.

It is, of course, possible, as Mr. Burkitt fears, that a few of the industries ascribed to the South African Magosian are, in fact, mixed assemblages of Middle Stone Age and Wilton industries from open sites—in at least one instance I share Mr. Burkitt's misgivings ; but there can be no doubt that industries which combine the techniques and types referred to occur from Somaliland to the Cape. This is placed beyond question by my excavations at Ladybrand in the Orange Free State, where sealed cave deposits have yielded three stages of the South African Magosian at a considerable depth under an obvious Wilton industry.

Avoidance of the term 'Magosian' by introducing a new local place-name for these industries in each territory would lead to a situation where we should have perhaps half a dozen names derived from places in the Union of South Africa, Southern and Northern Rhodesia, Kenya, Uganda and Somaliland, all meaning very nearly the same thing !

It should be remembered that workers in Africa have to contend with many special problems of terminology arising from the vast areas with which they are concerned. It was for this reason that the First Pan-African Congress on Prehistory in Nairobi in 1947 appointed a standing Consultative Committee on Terminology, representative of the five major areas of Africa, to assist those who find themselves confronted with the apparent need to introduce new terms.

B. D. MALAN

Archæological Survey,
Union Education Department,
University, Milner Park, Johannesburg.
Nov. 30.

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[1] *Nature*, **164**, 739 (1949).

DR. MALAN ably defends the use of a place name given to a local stone age industry for describing one occurring hundreds of miles away in a totally different area. He is averse to a multiplicity of local place names where the industries can be shown on typological grounds to be reasonably similar. Of course, he is correct in saying that the multiplicity of local names for cultures occurring in wide-flung areas must lead to confusion when these cultures can be shown to be identical ; but my great point is that a study of the typology of the two industries ascribed to the same culture by itself is not always sufficient to determine this with certainty, unless the industries in question are complex and comprise a number of specialized tools. Unless similar industries occur in the intervening districts, errors may easily arise when two somewhat similar industries are ascribed to the same culture, if separated from each other by hundreds of miles. Equally it may happen that two widely separated and not identical industries do belong to the same culture. One may be the product of the culture after a long period of migration, during which time some changes in the typology have taken place. A further difficulty is ever present. A newly discovered culture starts by receiving the place name where it was first identified ; for example, the Clacton culture at Clacton. Later the name gets transferred to some typological or technological characteristic of the industry. When we are informed that Clacton flints occur in Uganda, it is no longer suggested that the not very important culture of Clacton somehow reached Uganda ; but that folk there used a similar (quite reasonable) method of fracturing flint or other material occurring there.

It is all somewhat confusing for the unfortunate amateur. Personally, I favour the use of place names for cultures only, and that their use as descriptions of techniques should be frowned upon. Where it can be proved beyond cavil that two industries in widely separated areas are the products of the same culture, of course the first-used place name should be employed. But I feel as I grow older an increasing distrust of the typological method by itself. I am therefore inclined to suggest that frequently a multiplicity of local place names, to be sorted out by our successors when more information is available, is the lesser of two evils. Let me say at once that I am not suggesting that Dr. Malan's culture is not a true Magosian. But I am a bit afraid that the not very complicated industry at that insignificant waterhole in Uganda is having to carry a somewhat heavy burden. The whole problem is of great importance and interest, and one is grateful to Dr. Malan for his reasoned letter.

M. C. BURKITT

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Saturday, February 4

TEXTILE INSTITUTE (at the King's School, Macclesfield), at 10 a.m.—Conference on "The Preparation of Continuous Filament Yarns for Weaving and Knitting".

Monday, February 6

BRITISH WELDING RESEARCH ASSOCIATION (at 29 Park Crescent, London, W.1), at 3 p.m.—Sir Ben Lockspeiser: Opening of the "Research and Production" Exhibition (February 7–February 11).

SOCIETY OF ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. C. L. Boucher: Presidential Address.

INSTITUTION OF ELECTRICAL ENGINEERS, EDUCATION DISCUSSION CIRCLE (at Savoy Place, Victoria Embankment, London, W.C.2), at 6 p.m.—Discussion on "What Can Usefully be Taught to Students about Ferromagnetism?" (to be opened by Mr. F. Y. Poynton).

INSTITUTION OF ELECTRICAL ENGINEERS, NORTH-EASTERN RADIO AND MEASUREMENTS GROUP (at King's College, Newcastle-upon-Tyne), at 6.15 p.m.—Discussion on "Control and Measuring Equipment—Electronic versus Non-Electronic Apparatus".

INSTITUTION OF ELECTRICAL ENGINEERS, MERSEY AND NORTH WALES CENTRE (at the Liverpool Royal Institution, Colquitt Street, Liverpool), at 6.30 p.m.—Dr. J. S. Forrest: "The Performance of the British Grid System in Thunderstorms". (To be repeated on Thursday, April 13, at the Plaza Cinema, Swansea, at 6 p.m., and on Tuesday, April 18, at Queen's University, Belfast, at 6.45 p.m.)

CHEMICAL SOCIETY, OXFORD BRANCH (joint meeting with the ROYAL INSTITUTE OF CHEMISTRY, in the Physical Chemistry Laboratory, Oxford), at 8.15 p.m.—Dr. H. Irving: "Analytical Chemistry—Science or Art?". (All Fellows are invited.)

Tuesday, February 7

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. C. R. Bailey: "Rockets".*

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Prof. F. E. Zeuner: "The Stone Age of Peninsular India".

UNIVERSITY OF LONDON (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 5.15 p.m.—Dr. L. C. Thomson: "Visual Physiology".* (Further Lectures on February 14 and 21.)

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENTS SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Dr. G. N. Patchett: "A New Precision A.C. Voltage Stabilizer"; Mr. E. Bradshaw and Mr. M. Z. Tanycloglu: "An Instrument for the Measurement of Rate of Change of Power-System Frequencies".

INSTITUTE OF FUEL (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. D. Hicks: "Scientific Control in the Coal Industry".*

INSTITUTION OF ELECTRICAL ENGINEERS, EAST MIDLAND CENTRE (at Loughborough College, Loughborough), at 6.30 p.m.—Mr. G. T. Winch: "The Measurement of Light and Colour". (To be repeated on Monday, February 20, at the Liverpool Royal Institution, Colquitt Street, Liverpool, at 6.30 p.m.)

MANCHESTER GEOGRAPHICAL SOCIETY (at the Geographical Hall, 16 St. Mary's Parsonage, Manchester), at 6.30 p.m.—Prof. T. H. Oliver: "Venice, the Dolomites and Engadine".

CHEMICAL SOCIETY, EDINBURGH SECTION (joint meeting with the UNIVERSITY CHEMICAL SOCIETY, the ROYAL INSTITUTE OF CHEMISTRY and the SOCIETY OF CHEMICAL INDUSTRY, in the University Medical Buildings, Teviot Place, Edinburgh), at 7 p.m.—Prof. W. E. Garner, F.R.S.: "Some Aspects of Solid Reactions".

INSTITUTION OF THE RUBBER INDUSTRY (at the Royal Society of Tropical Medicine and Hygiene, 26 Portland Place, London, W.1), at 7 p.m.—Dr. L. Bateman: "Oxidation of Rubber".

Wednesday, February 8

CHEMICAL SOCIETY, NORTHERN IRELAND SECTION (joint meeting with the ROYAL INSTITUTE OF CHEMISTRY, the SOCIETY OF CHEMICAL INDUSTRY and the SOCIETY OF DYERS AND COLOURISTS, at the Queen's Hotel, Belfast), at 7.30 p.m.—Mr. E. F. Eaton: "Colours in Food".

INSTITUTION OF THE RUBBER INDUSTRY, WEST OF ENGLAND SECTION (at the George Hotel, Trowbridge), at 7.45 p.m.—Mr. H. Smith: "Press and Mould Design".

Thursday, February 9

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Mr. D. R. Newth: "Eggs".*

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Discussion on "Succulent Plants" (to be opened by Dr. E. M. Delf, Prof. T. A. Bennet-Clark and Mrs. Vera Higgins).

CHEMICAL SOCIETY, HULL SECTION (joint meeting with UNIVERSITY COLLEGE SCIENTIFIC SOCIETY, in the Science Lecture Theatre, University College, Hull), at 6 p.m.—Dr. H. W. Thompson, F.R.S.: "Some Recent Applications of Infra-Red Spectroscopy". (To be repeated on Wednesday, March 22, at the Engineers' Club, Albert Square, Manchester, at 6.30 p.m.)

CHEMICAL SOCIETY, BRISTOL SECTION (joint meeting with the ROYAL INSTITUTE OF CHEMISTRY and the SOCIETY OF CHEMICAL INDUSTRY, in the Department of Chemistry, The University, Bristol), at 7 p.m.—Prof. M. Stacey: "Studies of some Organic Fluorine Compounds".

ROYAL INSTITUTE OF CHEMISTRY, LONDON AND SOUTH-EASTERN COUNTIES SECTION (at the Acton Technical College, High Street, Acton, London, W.3), at 7.30 p.m.—Dr. E. Lester Smith: "Vitamin B_{12}".

PHARMACEUTICAL SOCIETY, MANCHESTER, SALFORD AND DISTRICT BRANCH (in the Council Chamber, Houldsworth Hall, Manchester), at 7.45 p.m.—Mr. A. F. Plowright: "Pharmaceutical Education with Special Reference to Recent Changes".

Friday, February 10

OIL AND COLOUR CHEMISTS' ASSOCIATION, MANCHESTER SECTION (at the Engineers' Club, Albert Square, Manchester), at 2 p.m.—Mr. N. D. P. Smith: "The Use of the Electron Microscope in Paint Problems".

CHEMICAL SOCIETY, BIRMINGHAM SECTION (in the Main Chemistry Lecture Theatre, The University, Edgbaston, Birmingham), at 4.30 p.m.—Sir Ian Heilbron, F.R.S.: "Fifty Years of Organic Chemistry".

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Anniversary Meeting, followed by Annual General Meeting.

INSTITUTION OF ELECTRONICS, NORTH-WESTERN BRANCH (in the Council Chamber, College of Technology, Manchester), at 6 p.m.—Dr. W. Summer: "Television and the Human Eye".

INSTITUTE OF INDUSTRIAL ADMINISTRATION, MANCHESTER CENTRE (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Dr. M. Markowe: "Human Relations in Industry".

PLASTICS INSTITUTE (at the Engineers' Club, Albert Square, Manchester), at 6.45 p.m.—Mr. Maldwyn Jones: "Polythene".

ROYAL STATISTICAL SOCIETY, SOUTH WALES GROUP of the INDUSTRIAL APPLICATIONS SECTION (at the Agricultural College, Usk), at 7 p.m.—Mr. M. Sampford: "The Application of Statistical Method in Agriculture".

SOCIETY OF CHEMICAL INDUSTRY, FINE CHEMICALS GROUP (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 7 p.m.—Mr. J. Davidson Pratt: "The Economics of the Fine Chemical Industry".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT BOTANIST (with Honours degree in botany or agricultural botany) at Sourhope Experimental Farm, Yetholm, Kelso—The Secretary, Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh (February 11).

GRADUATE BIOCHEMIST to teach microbiology, chemistry and physics in relation to food—The Secretary, Smithfield College of Food Technology, Eagle Court, St. John's Lane, London, E.C.1 (February 11).

SENIOR ASSISTANT IN THE TECHNICAL COLLEGE, Bradford, to give general assistance to the Principal, and to participate in the teaching of industrial administration and management—The Director of Education, Town Hall, Bradford (February 11).

ASSISTANT LECTURER IN THE DEPARTMENT OF INORGANIC AND PHYSICAL CHEMISTRY—The Registrar, The University, Leeds 2 (February 20).

TECHNICAL OFFICER II (with a good Honours degree in geography or geology) in the Technical and Scientific Register, for work in the employment service of the Register dealing mainly with graduates in geography, geology and psychology—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting G.311/49A (February 20).

ASSISTANT ANALYTICAL CHEMIST (male) in the Government Analyst's Laboratory, Salisbury—The Secretary to the High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (February 25).

DIRECTOR, CENTRAL BUILDING RESEARCH INSTITUTE, Roorkee—The High Commissioner for India, General Department, India House, Aldwych, London, W.C.2, quoting No. 474E (February 27).

ASSISTANT PHYSICIST (with good Honours degree in physics) IN THE PHYSICS DEPARTMENT of the Sheffield National Centre for Radiotherapy—The Secretary, Broom Cross, Tree Root Walk, Sheffield 10 (February 28).

PHYSICIST at a Ministry of Supply Research Establishment near London, for duties primarily concerned with technical administration of large group of scientific and ancillary staff working on physical and mathematical problems associated with explosives and armaments—The Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.13/50 (February 28).

ELECTRICAL ENGINEER, or PHYSICIST with knowledge of some aspect of the application of electronics (other than radio), in the N.C.B. Central Research Establishment at Stoke Orchard, near Cheltenham—The National Coal Board, Establishments Branch (Personnel), Hobart House, Grosvenor Place, London, S.W.1, endorsed TT.185 (March 3).

SUPERINTENDENT OF THE RESEARCH GLASSHOUSES (should possess a degree in horticulture or its equivalent, with good experience of modern glasshouse management)—The Secretary, East Malling Research Station, East Malling, Maidstone, Kent (March 4).

RESEARCH CHEMIST FOR THE PLANT PROTECTIVE CHEMISTRY SECTION, to work with other chemists and biologists on chemical control of pests and diseases of fruit and hops—The Secretary, East Malling Research Station, East Malling, Maidstone, Kent (March 10).

CHAIR OF ELECTRICAL ENGINEERING at University College—The Academic Registrar, University of London, Senate House, London, W.C.1 (March 13).

Lecturer in Psychology at the University of Melbourne—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (March 13).

Derby Chair of Anatomy—The Registrar, The University, Liverpool (March 18).

Lecturer in Statistics in the Department of Mathematics in the United College—The Secretary, The University, St. Andrews (March 31).

Senior Lecturer or **Lecturer in Pharmacology** in the University College of the West Indies—The Secretary, Senate Committee on Higher Education in the Colonies, University of London, Senate House, London, W.C.1 (March 31).

I.C.I. Research Fellowships for research in physics, chemistry, biochemistry, engineering, metallurgy, pharmacology, chemotherapy, or related subjects—The Secretary, Board of Research Studies, The Old Schools, Cambridge (April 30).

Lecturer in Entomology, and an **Assistant Lecturer in Zoology**—The Registrar, The University, Nottingham.

Senior Assistant in Pharmaceutics in the Welsh College of Pharmacy, Cardiff Technical College—The Director of Education, City Hall, Cardiff.

Senior Lecturer in the Department of Aircraft Propulsion—The Registrar, College of Aeronautics, Cranfield, Bletchley, Bucks.

Electrical Engineers by the Central Electricity Board, Federation of Malaya, qualified for (*a*) Electrical Generation (Ref. No M.N.25014/3B) or (*b*) Electrical Distribution (Ref. No. M.N.25016/3B)—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting the appropriate Ref. No.

Electrical Engineers in the Electrical Department, Gold Coast—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting 27326/16.

Civil Engineer for the investigation of water supplies in Sierra Leone—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27322/139.

Executive Engineers in the Public Works Department, Tanganyika—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No 27322/140.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Department of Scientific and Industrial Research: Radio Research. Special Report No. 19: Lateral Deviation of Radio Waves reflected at the Ionosphere. By W. Ross. Pp. iv+32. (London: H.M. Stationery Office, 1949.) 9*d*. net. [2411

Air Ministry: Meteorological Office. Professional Notes, No. 98: Rainfall in East Scotland in relation to the Synoptic Situation. By R. F. M. Hay. (M. O. 420r.) Pp. 18. (London: H.M. Stationery Office, 1949.) 6*d*. net. [2411

University of Durham: King's College, Newcastle-upon-Tyne. Academical Year 1949–1950. Pp. 873. (Newcastle-upon-Tyne: King's College, 1949.) [2811

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British Hat and Allied Feltmakers Research Association. Second Annual Report of the Director of Research for Year ending August 1949. Pp. 12. (Leeds: The University, 1949.) [2811

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Major Diseases and Competitors of the Cultivated White Mushroom. By Fred. C. Atkins. Pp. 24. (Peterborough: Mushroom Growers Association, 1949.) 5*s*. [2811

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Man the Tool-Maker. By Kenneth P. Oakley. Pp. v+98+2 plates. (London: British Museum (Natural History), 1949.) 2*s*. 6*d*. [512

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Old, Rare, and Fine Books and Papers on Zoology, Natural History, Science, Botany, etc. (Catalogue No. 4.) Pp. 54. (College Park, Md.: Biological Book Service, P.O. Box 401, 1949.)

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Notes on 'Oxoid' Culture Media. Pp. 6; with Samples of Nutrient Broth and Nutrient Agar in tablet and granule forms. (London: Oxo, Ltd., 1949.)

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UNIVERSITY EXPANSION

FOLLOWING the reports on university development issued in 1944–45, the Association of University Teachers has published a report on university expansion based on factual inquiries and three years experience of the greatly increased student numbers under the new conditions. The report, which was adopted by the Council of the Association on May 20, 1949, records full agreement with the broad lines of policy and the recommendations of the University Grants Committee's report and of that on university awards. It emphasizes, however, that the universities are concerned with a wider problem than that of increasing the number of students with high academic attainments; they should also seek to expand the volume and improve the quality of teaching and research at all levels, as well as to improve the quantity and quality of research workers. The report accepts the figure of 18,000 as the probable annual intake of students, but agrees with Dr. W. W. Grave that the assessment of 5,000 as requiring no grant is too speculative, and also that it is undesirable that a stated number of grants should be made irrespective of the academic level of the new entrants. The report suggests that the number of grants should vary according to the number of applicants considered suitable; but it is probable that there will be a large enough entry of good quality to justify the provision of more than 11,000 awards.

The Association appears to be satisfied that there is a sufficient reserve of talent for expansion to continue at the present rate, but considers that the 'working party's' report on university awards has not brought out clearly the necessity of awards for students entering a university at a more advanced age. Here again the report endorses Dr. Grave's view as well as his argument that the final selection of such candidates should rest with the universities. It is agreed that the problems raised require further investigation; but the report does not pursue the question further than to observe that the financial value of the grants also requires improvement, so that family considerations do not remain a bar to application. It refers appreciatively to the value of the work of the Hankey Committee, and stresses the need for expansion in the numbers of those with a general degree and the value of men with good second-class degrees.

The report considers in some detail the expansion of studies both in the faculties of arts and in those of science. At present, larger numbers of men and women are applying for admission to the arts faculties than can be accepted, and the report stresses the prime importance of general agreement at least as to the approximate number of students to be admitted. To achieve this it is necessary to have an idea of the purpose to which students will put their studies after leaving the universities. The expansion of numbers reading arts cannot be built on any vague principle of balance with the number of science students, but must depend on some calculation, based on general social and educational needs, which has due regard to the prospects of employment.

The report does not, indeed, suggest that subjects of study are to be chosen only for their vocational use, though it recognizes that important changes of curriculum may be advisable. Its comments on the expansion of studies in the faculties of science are more reserved, for the Hankey Committee reports had not then appeared; although they are based on inquiries covering two-thirds of the science departments of all universities and university colleges in Britain, apart from Oxford, Cambridge and Belfast. These inquiries indicate that in some subjects, such as mathematics, the demand for graduates is appreciably less than double the 1939 output, whereas in biological subjects in general, psychology and geology, more than double the 1939 output is expected to be absorbed. There is room for expansion in the number of students in agriculture, and special stress is laid on the acute shortage of women science teachers in the schools, which is now affecting the numbers of girls entering the science departments in the universities.

The two most important features of the report are, however, its discussion of staffing problems generally and of the expansion of social studies. Apart from accommodation, the practical limit to the rate of expansion is still that of staffing; and the general shortage of qualified staff makes the Association unwilling to support at the present time any proposal to establish several new university institutions which would bring a demand for many administrators and heads of departments. Not only is careful planning required here, but also, to avoid the lowering of standards in existing universities, the academic staff should be increased proportionately with the increase in students, both from the point of teaching and of research. This is true of the faculties of arts as well as of those of science. Besides emphasizing the dependence of a healthy academic life on the active prosecution of advanced studies by the teachers, the report points to the need for more grants for research and postgraduate studies on social and historical problems, on foreign languages and cultures, etc. In respect of science, besides stressing the need for a proper balance between teaching and research, which has been seriously threatened by the post-war expansion, the report directs attention to the importance of an adequate staff of trained laboratory stewards and technicians, which could do something to ease the present strain on lecturers. Comment is also made on the inadequacy of library grants at many universities and the need for increased staff as well as funds.

As regards social studies, the Association supports the view that it is a primary duty of the universities to carry out research in this field. This is much more important than the vocational courses which at present occupy so much of the time of the universities in this field. Here, however, the difficulty of staffing is even more acute, and expansion must wait on the training of the personnel required. Meanwhile, closer co-operation between the universities and the numerous institutes already concerned with social studies is desirable, while a survey of the prospects of employment for graduates in this field is advisable, as well as further consideration of the selection of students for such studies.

Apart from its emphasis on the questions of staff, this report from the Association of University Teachers affords independent support for many of the views generally expressed in the last report of the University Grants Committee. There are, indeed, reservations on salaries: those suggested do not, in fact, ensure the modest standard of living to which the University Grants Committee suggests a university teacher is entitled, nor do they take account of such specific academic needs as the accumulation of a private library, membership of learned societies and foreign travel. Also the report makes no comment on the important recommendation of the 'working party' on university awards regarding a university clearing house. That matter, however, was dealt with more explicitly in the discussion on the selection of students for open scholarships and awards, which took place at the Home Universities Conference on December 18, 1948*. Sir Philip Morris, who opened the discussion, stressed the fact that the 'working party' laid down quite frankly the principle that the right of admission should be vested in the university, and he also stressed the need for variety in the method of award. He then went on to commend a clearing-house system for which the universities themselves should accept responsibility, and was convinced that some machinery of this nature must be found. He hoped that by some such common action or other system of dealing with applicants for a university education, the universities would succeed in ensuring dispersal in place of the present system of allocation through State scholarships, in spite of its efficiency. Sir Philip also urged that, as regards increasing their own scholarships, the universities should take a considerable part in the making of awards if variety is to be maintained; but he laid equal stress on the value of establishing and maintaining even closer relations with the schools.

Lord Chorley, who presided at this discussion, thought that the report of the 'working party' underlined and accepted the views which the Association of University Teachers put forward so long ago as 1944; but he pointed out that, nevertheless, since it would be quite impossible to take into the universities during the next few years all those mentally equipped to benefit by a university career, we cannot avoid the problem of selection, nor, indeed, that of eliminating the unfit at present entering the universities. This, Lord Chorley thought, is the least satisfactory part of the report of the 'working party', due possibly to meagre representation of the universities on the 'working party'. Lord Chorley also indicated his readiness to explore fully the possibilities of such a system as that of the Civil Service Selection Board; but in this, however, he was not followed by Dr. Grave, who said he feared that the clearing-house system for university admissions might thus eventually replace that by the universities themselves. Dr. Grave was also nervous about the large proposed increase in awards by local authorities, and was less confident than Sir Philip Morris that there would be a sufficiently increasing supply of suitable candidates.

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* Report of the Proceedings of the 1948 Conference of the Universities of Great Britain and Northern Ireland. Pp. 125. (London: Association of Universities of the British Commonwealth.) 1*s*.

The most impressive features of the discussion generally were the recognition of the vital importance of maintaining standards, and of ensuring that the only criteria for admission to a university should be the personal merits of the candidate. All the misgivings and differences of opinion about the practicability of a clearing house, of a selection board and of the dangers of local-authority awards as opposed to university awards, all really turn on the views held as to their effect on standards and the exclusion of meritorious candidates through such factors as exceptional competition at a particular university or in a particular locality. Sir Griffith Williams, deputy secretary to the Ministry of Education, said that the Ministry wishes to take full account of the views of the universities in determining policy, and in particular on the matter of the recommendations of the local authorities and the question of allocation. The spirit of his brief intervention throws down a distinct if friendly challenge to the universities for constructive thought on these issues, and the full and swift exploration of any means of providing a satisfactory and generally acceptable solution of the problem of university expansion.

The increased economic stringency which has beset Great Britain since the discussion, with the greater difficulties which will be met in providing new buildings, make it all the more imperative that the question of numbers of students should be handled wisely. In the years ahead the nation will, indeed, have need of all the services which the most promising and ablest minds leaving its schools each year can give; and it can ill afford that any such should not be brought to full fruition. Even less can it afford the waste of university resources on those incapable of profiting by such training, or the depreciation of university standards from whatever cause. Zeal to ensure that neither lack of means nor any other factor closes the door of a university to anyone capable of profiting by it must be matched by zeal to see that the conditions within the university—buildings and equipment, staff and amenities—are such that those admitted enjoy the opportunity of a university life in its truest and finest sense.

PLANT PATHOLOGY

Plant Pathology

By Sir Edwin J. Butler and Dr. S. G. Jones. Pp. xii+979. (London: Macmillan and Co., Ltd., 1949.) 63*s*. net.

THE publication of this outstanding work is an event of no mean importance in the history of plant pathology in Great Britain. Whereas Germany has produced Sorauer's "Handbuch der Pflanzenkrankheiten", Italy Ferraris's "Patologia e Terapia Vegetale", France Arnaud's "Traité de Pathologie végétale" and Viennot-Bourgin's "Les Champignons parasites des Plantes Cultivées", and the United States Heald's "Manual of Plant Diseases", Britain has hitherto made no comparable contribution to the science. For many years students had to rely on Massee's "Diseases of Cultivated Plants and Trees" and Duggar's "Fungous Diseases of Plants", and while in the last two decades valuable English books, including Brooks's "Plant Diseases" and others on various aspects of plant pathology, have appeared, nothing yet published in Great Britain has attempted such a comprehensive and thorough treatment of the subject.

The collaboration of the two authors was indispensable to the work. It would have been humanly impossible for the late Sir Edwin Butler, with his onerous duties as secretary of the Agricultural Research Council, to have written the book single-handed, so plant pathology owes much to Dr. Jones, who induced Sir Edwin to undertake the work with his help. While he was director of the Imperial Mycological Institute, Sir Edwin Butler seriously considered a second edition of his much-prized "Fungi and Disease in Plants"; but the project was abandoned before work on it was started. The present book is on similar lines to the first; but diseases of importance in Great Britain and some from other temperate countries replace diseases found in the tropics. Everyone will share the junior author's regret that Sir Edwin Butler did not live to see the fruit of his labours.

The first part of the work is concerned with general principles and was written mainly by the senior author. It comprises nine chapters, with an appendix on the classification of fungi. It deals with: (1) the nature of disease organisms, (2) the life-histories of parasitic fungi, (3) the parasite in relationship with its host, (4) resistance and susceptibility, (5) the influence of environmental and nutritional conditions on plant diseases, (6) morbid anatomy, (7) the principles of plant disease control, (8) virus diseases, and (9) deficiency diseases. The hand of the master is seen in every chapter, and the thorough manner in which each subject is treated is characteristic of the man. It constitutes an excellent introduction to the detailed discussion of selected diseases which comprises the second part. The chapter on morbid anatomy, a subject of special interest to the senior author, is particularly noteworthy, and that on control gives, *inter alia*, a brief but authoritative account of quarantines that is refreshing to read.

The second part gives detailed accounts of selected diseases, separate chapters being devoted to diseases of the following host groups: cereals, pasture and forage crops, potatoes and root crops, pulse crops, vegetables, fruit, ornamental and other plants, and trees. The treatment throughout is excellent. A short historical introduction is usually followed by a description of symptoms, the causal agent of the disease, its physiological characteristics, life-history, and control; but the method adopted is by no means stereotyped. The information available is presented in a fully assimilated form with copious references to original papers, cited in a bibliography appended to the account of each disease.

In a work of such a high standard it may seem invidious to make any suggestion for improvement; but one could not help wishing that the authors had given a somewhat fuller account of the modern developments in spraying equipment and techniques that have been such a prominent feature of British plant protection in recent years. For example, nothing is said about the standardization of nozzles made possible by the introduction of stainless steel disks, the air-blast type of sprayer, the possibility of low-volume sprays, or the use of helicopters. Disinterested, up-to-date information on the subject is difficult to obtain and would be correspondingly valuable, though perhaps full treatment would have taken more space than the authors could afford. The control of plant disease is the ultimate objective of all plant-pathological work, and this should never be forgotten, even by the student.

Consideration of space also probably explains the absence of any account of phytopathological technique. This again is changing every day as new methods are devised; but technique is extremely important in research, and the student should beyond all doubt be carefully trained in its methods.

The classification of the fungi set forth in the appendix is a little out of date. The Ancylistales are now the Lagenidiales, the Entomophthorales have three families, *Pseudopeziza*, *Dasyscypha* and *Sclerotinia* are usually placed in the Helotiales and not the Pezizales, and the Uredinales are now divided into only two families. However, no two mycologists are likely to agree in all points about classification, the comparatively chaotic state of which is one of the obstacles to the progress of plant pathology to day.

The illustrations throughout are a feature of the volume. Many are original line drawings by Dr. Jones, and these are beautifully executed. For the selection of published figures he has taken the trouble to go to the original sources. Even though well supplied with illustrations, there is no doubt that coloured plates showing typical deficiency diseases (none is illustrated in Part 1) would have added to the value of the work and that some of the striking photographs of plant viruses by the electron microscope might well have been provided. In a plant-pathological work of this sort it seems a pity to use non-pathogenic fungi for figures when there is such abundant pathological material available for illustration. These are, however, minor blemishes that can easily be remedied in a further edition.

The work is essentially a book for the university student and research worker in plant pathology, though advisory officers and agricultural administrators and even the 'practical man' may find much of interest and profit within its leaves. It will doubtless do much to stimulate interest in plant pathology in Britain and, it is hoped, elsewhere. The student has now an excellent, modern, British text-book to initiate him into the intricacies of the subject, and it is likely that the volume will be a standard work of reference for many years to come. A comprehensive volume such as this probably represents the limit of size that is feasible, and, in future, diseases of particular host groups will probably have to be discussed in separate volumes. Any attempt to make the accounts of diseases of the various hosts complete would swell the book to an impracticable size, and the authors were undoubtedly right in restricting the scope of their work to the more important diseases under the common host attacked. It is satisfactory to note that plant pathology is interpreted as including all disease-producing agents—bacteria, fungi, viruses, soil deficiencies, and physiological disorders, though nothing is said about eelworms, which in Great Britain are usually regarded as a separate subject. The book therefore gives the student a wide outlook—a specially pleasing feature in view of the tendency to over-specialization that can be discerned in some quarters.

There is some evidence that the work has taken a long time to print, and the second author has found it difficult to keep the text up to date. For example, the agent of brown rust of barley is now named *Puccinia hordei*; no reference is made to the noteworthy paper of Risbeth on *Fomes annosus*, or to Nicholas's work on the diagnosis of deficiency diseases by the tissue technique. But, with printing taking as long as it now does, it is inevitable that books should suffer in this way, and it is to be hoped that printers may be able to do something to speed up the publication of scientific work. Apart from this the publishers are to be congratulated on the fine quality of the production. There are few misprints and few slips in the text.

The work is undoubtedly a most valuable contribution to phytopathological literature, not only of Great Britain but also of the world. It is an achievement the full significance of which will probably be revealed only as the years go by. At this juncture, when plant pathologists are so urgently required, it is particularly welcome, and the ripe scholarship and massive learning that have gone into its production will, it is to be hoped, fructify for many generations in the better training of plant pathologists and a correspondingly increased effectiveness in the fight against plant disease.

S. P. WILTSHIRE

STRUCTURAL GEOLOGY

Principles of Structural Geology

By Prof. Charles Merrick Nevin. Fourth edition. Pp. xiii+410. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1949.) 48*s*. net.

THE new edition of this popular and attractive text-book will be widely welcomed. Much of the detail has been reorganised and re-written, and many new sections and illustrations have been added. The most notable addition is a final chapter on "Laboratory Exercises", a title which somewhat obscures the real utility of the methods described in their application to field work. The principal method discussed is that of orthographic projection. Less space is devoted to the still more powerful weapon of stereographic projection; but the author is to be congratulated on having introduced it into a text-book for the first time. It is to be hoped that his treatment will popularize the application of this projection to the many structural problems which can readily be solved with its aid. Useful exercises in stratum-contouring are also included. In the presentation of structural data, no uniform system has been adopted; adherence to a single convention would doubtless be an improvement. It would also be useful to include a short discussion of the limits of accuracy required in structural measurements; in this book one or two dips are recorded to 30′ without any indication that such 'accuracy' can rarely be justified. The chapter on intrusion tectonics has been effectively re-written by Dr. E. B. Mayo. Here, it may be suggested that a table of map symbols (including, but not confined to, those used in mapping intrusions and plutonic complexes) would be an appropriate addition.

The systematic account of structures is generally sound. The treatment of competent beds is much improved, but the distinction between symmetric and isoclinal folds is less clear than in the first edition. One or two errors call for future correction: for example, fold-closure is not synonymous with dying-out (pp. 41 and 43), and it is quite wrong to state (p. 170) that "the true direction of plunge will always parallel the strike of the cleavage". Here, and also in the introduction to the stereographic projection method, the value of plunge determinations and their utility might well be elaborated, using the results of Wegmann's work in Finland as a guide and in further illustration. Moreover, it may be remarked that for Lugeon and Argand a nappe is not necessarily based on a thrust; according to Argand, who knew the ground much more intimately than any critic, the reversed limb of the Dent Blanche nappe, though greatly thinned, is never cut out (cf. p. 119). Reference to the Alps suggests the question whether, in a book on structural geology, the Alps should be dismissed in twenty-nine lines while, for example, submarine valleys receive nearly 130.

In the introduction the importance of discrimination between fact and hypothesis is emphasized. Structures can be seen and measured; movements can often be inferred; but knowledge of the active forces is rarely more than hypothetical. Yet the author, very surprisingly, proposes (pp. 48–49) that structural terms should have genetic significance. This implied confusion between description and interpretation is perhaps responsible for his difficulty with over- and under-thrusting (p. 128). Taken as a whole, the standard of the new edition marks a real advance in the presentation of an admittedly difficult subject. A few criticisms have been made, but they are intended to be constructive, and they are offered in the hope that in future editions this excellent book may yet become the leader in its class.

EVOLUTION OF MAN

Early Man

A Survey of Human Origins. By Alan Houghton Brodrick. Pp. 288+13 plates. (London: Hutchinson's Scientific and Technical Publications, 1948.) 18*s*. net.

POPULAR expositions on the subject of early man can roughly be divided into two categories: those of the journalistic type which are little more than dramatized versions of more authoritative accounts, 'written down' for the apparently unintelligent reader; and those which strive to be sober and critical surveys based on a careful study of scientific documents, and, in some cases, of the original evidence. Mr. A. H. Brodrick's book finds its place in the latter category. The author weighs the available evidence (much of it still very meagre) with due care, and presents his conclusions with commendable restraint. Clearly his book is intended for the intelligent reader. But this is not to say that it is written in an unattractively pedagogic style; on the contrary, the story of discovery is presented in the form of a stimulating narrative which flows easily from one item to another, and which conveys (in brief) a vivid impression of the whole field of palæo-anthropology as it stands to-day.

During the past fifteen years or so, discoveries relating to early man have been most remarkable for their abundance; it is therefore very appropriate that a book of this sort should be available which brings the story of human evolution up to date for the general reader. This the author does very effectively, and in his book references will be found to a number of significant discoveries which otherwise have not yet found their way into popular accounts of human evolution. Among such novel features are descriptions and discussions of the Neanderthal remains found in Italy, the palæolithic cave paintings at Lascaux, the relics of *Pithecanthropus* and allied forms found by Dr. von Koenigswald in Java shortly before the Second World War, the Acheulean site at Olorgesailie in Kenya, palæolithic industries in Asia, the Australopithecine fossils of South Africa, the Swanscombe skull fragments, and the neanderthaloid skeleton from Uzbekistan.

But new discoveries proceed apace, and even since this book was published in 1948, still more new finds of great significance have been made. Therefore, since Mr. Broderick's book is, without doubt, one of the best popular expositions of early man now available, it is to be hoped that a new edition will not be long forthcoming.

A HISTORY OF SCIENCE

Science, Past and Present

By Dr. F. Sherwood Taylor. New edition. Pp. x+368+28 plates. (London: William Heinemann, Ltd., 1949.) 12*s*. 6*d*. net.

WE welcome this new edition of the work of the keeper of the Museum of the History of Science in Oxford. Dr. F. Sherwood Taylor's "Science, Past and Present" was first published in 1945 and was immediately reprinted. It is appropriate that it should now be presented in a larger edition and produced in a style worthy of its contents.

The book, in simple yet scientific language, depicts science as a living, growing organism and thereby demonstrates its powers and limitations, and so sets it in its place among the various activities of mankind. Dr. Taylor has in mind the needs of the intelligent layman, the 'sixth form' and the science specialist who wishes to see the place of his limited study in a greater scheme of things. It is pleasing to note that this book is entirely free from the political prejudices and propaganda which mar so many works which deal with the history and social applications of science.

The story of mechanics, physics and chemistry, biology and geology, which is the 'stock in trade' of most writers on the history of science, is enriched by the addition of an account of the development of other parallel studies such as public health, the methods of science and its functions. The author faces the problems of the limitations of science. "Those who remember that scientific laws are summaries of observations and not legal enactments will have no difficulty in discovering the phenomena to which they can safely be applied." One recalls the lines of the poet Walt Whitman in speaking of scientific men:

> "Gentlemen ! to you the first honours always :
> Your facts are useful and real—and yet they are
> not my dwelling ;
> (I but enter by them to an area of my dwelling.)"

One of the most useful features of Dr. Sherwood Taylor's book is the way in which he supports each chapter with a set of extracts from contemporary scientific documents. Such material is not easily available in sufficient quantity, and the work under review is a valuable additional source. It remains to be said that there is a good bibliography, that the pictures and diagrams are of first-rate quality and that the book is beautifully produced.

W. L. SUMNER

Aristotle's Prior and Posterior Analytics

A revised Text with Introduction and Commentary by W. D. Ross. Pp. x+690. (Oxford: Clarendon Press; London: Oxford University Press, 1949.) 42*s*. net.

IT would be both impertinent and inappropriate to attempt any more than to accord to this monumental work the welcome which its origin and importance make obvious. To this perhaps may be added the gratitude of men of science—in the widest sense—to Sir David Ross for his labours, and no less for the gracious form in which they are presented. One hundred and forty-five years have gone by since the last critical edition of the "Analytics" was published; several studies have appeared during that time. These find their place in the present text, as well as the work of two of the great Renaissance scholars.

The rapid growth of many-valued logics in recent years brings to mind the need for continuous recollection of the rock whence they are hewn; it is not a little remarkable that—in many cases—the savants most creative in progressive researches are just those best versed in the long history of their subject. To them and their like this revised text, introduction and commentary should make its own special appeal.

F. I. G. RAWLINS

Evolution of the Forebrain

The Fundamental Anatomy of the Telencephalon with special reference to that of *Testudo geometrica*. By Dr. G. W. H. Schepers. Pp. xi+212. (Cape Town: Maskew Miller, Ltd.; London: John Clark, 1948.) 50*s*.

IN the words of the author, this book concerns itself with a complete re-analysis of the reptilian telencephalon as an aid to determining the manner and mechanism of the forebrain evolution. This telencephalon has attracted much interest on all sides from students concerned with the evolution of the forebrain.

The choice of *Testudo geometrica* lies with the general arrangement of the forebrain, suggesting primitiveness and a simplicity which are not due to a lack of any of the essential structural elements. The book endeavours to cover the work done in this field as a whole and at the same time make a careful analytical summary of the telencephalon of the *Testudo geometrica*.

The preface by Kappers gives an indication of the importance of this contribution, and the book must prove very valuable to students of brain research whether they be anatomist or physiologist.

Faune de Belgique

Poissons marins. Par Dr. Max Poll. Pp. ii+452. (Bruxelles: Musée Royal d'Histoire Naturelle de Belgique, 1947.) 420 francs.

LONGCHAMPS (1842), Van Beneden (1871), Gilson (1921) and certain others have made contributions of greater or less importance to the knowledge of the marine fish fauna of Belgian waters. But not until the recent publication of "Poissons Marins" by Max Poll has any comprehensive and systematic work covering the subject as a whole been available. In this book, the author not only synthesizes the results of previous workers, but also makes important contributions of his own to the knowledge of species already familiar in the region and of others recorded there for the first time. In addition to reasonably full systematic descriptions of each species, there are also brief notes on time and place of spawning, seasonal and other migrations, food, habits and economic importance. The usual keys to aid identification are included, and the book is amply illustrated; but some of the drawings could be improved upon. Nevertheless, this is a valuable publication.

G. A. STEVEN

Mathematics

A Text-Book for Technical Students. By Bevan Brunel Low. Second edition. Pp. vii+464. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1948.) 17*s*. 6*d*. net.

THE first edition of this excellent text-book appeared in 1931, and it has been reprinted several times. It is amazing how, in a single volume, the author contrived to give some account of algebra, logarithms, trigonometry, plane and solid co-ordinate geometry, geometrical conics, empirical laws, differential and integral calculus, differential equations, finite differences and Fourier's series. Now he has added a chapter on determinants. There are many worked examples throughout the book and nearly eight hundred examples for solution, with answers. The diagrams are exceptionally well drawn. The book will be of great value to technical students.

The Birds of Concord

By Ludlow Griscom. (New England Bird Studies, 2.) Pp. xi+340+16 plates. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1949.) 27*s*. 6*d*. net.

THE area dealt with is roughly one hundred square miles in north-east Massachusetts and is of special interest, since the great American naturalist William Brewster began his ornithological career there in 1868 and for nearly fifty years made continual observations. Brewster's diaries consist of fifty volumes and are now in the Museum of Comparative Zoology at Harvard. Since Brewster's death in 1919 others have carried on the work, so that there are unbroken observations on this area covering nearly eighty years.

The book is divided into two parts: (1) "Population Trends" and (2) "Birds of the Concord Region". In this latter part, in addition to the systematic list, there are interesting notes on migration routes, seasonal bird-life and newly created habitats. Part 1 deals with a variety of subjects; it is the most interesting section of the book and is well worth consideration by bird students in Great Britain. Starting with a description of the area, climate and vegetation, the author goes on to give details of the effect of civilization and disturbances. This section is of particular interest on account of the long period in which the area has been under close observation. The remainder of this part consists of remarks on the fluctuations in numbers of some birds and animals and the importance of adaptability, followed by some thirty pages on population, declines and increases.

Mr. L. Griscom does not agree that there are periodic cycles in birds and considers that in New England, at least, the winter irruptions of the snowy owl may be due to failure of food supply in the north or to over-population—this owl is a prolific breeder and lays from four to ten eggs. He also gives his reasons for the fluctuations of the ruffed grouse, and brings to a close his discussion on cycles with a note on some general principles of population trends. There are sixteen excellent photographs by various members of the National Audubon Society.

RENÉ DESCARTES (1596-1650)

By Prof. HERBERT DINGLE

On February 11, 1650, René Descartes died in Stockholm in his fifty-fourth year. Galileo had been dead for eight years and Newton was a child of seven. It is customary now to think of Galileo and Newton as the founders of modern science and of Descartes as 'the father of modern philosophy', and in retrospect the titles are justified. The principles of the former thinkers are implicit in all subsequent science and the text of the latter has been explicitly anatomized by all later students of philosophy. Reciprocally, of course, philosophers have regretted the gaucheries of Galileo and Newton, while men of science have forgotten Descartes. There is reason, therefore, in the classification that has been made, but it would have seemed strange in the seventeenth century. At that time all three were placed in the same genus, and, if fertility of crossing is a valid criterion, they were as thinkers of the same species also. The divergence that followed was inevitable, but none the less unfortunate. Let us, three hundred years after his death, try to estimate the scientific significance of Descartes.

His greatest contribution to the fundamentals of all thinking, whether it be called scientific or philosophic, seems to me to lie in his first principle—that the basis of one's system should be that which one cannot doubt. As a rough generalization we may say that earlier philosophers had started with what one ought not to doubt, and later ones with what it is convenient not to doubt. Descartes almost alone took the *impossibility* of doubt as the only valid token and honestly tried to discover what bore it. His solution—the famous *Cogito ergo sum* and its consequences—was perhaps scarcely worthy of the discernment that led to it, but had he done nothing more than sow this one seed of truth and left it to germinate in its own time, he would still have earned his title of the father of philosophy.

At the present time, it is true, its germination seems remote. To change the metaphor, in an age when building material is plentiful, a simple plan available, and workers eager and numerous, the question of the stability of the foundations is apt to be regarded as a tiresome hindrance to progress, and therefore one to be evaded or given whatever answer will most effectively prevent it from obtruding itself. For example, Sir Arthur Eddington, wishing to establish a philosophy on the impregnable rock of pure reason, found the existence of other people neither obvious nor deducible; he therefore *assumed* it. "For reasons which are generally admitted, though I should not like to have to prove that they are conclusive," he wrote[1], "I grant your consciousness equal status with my own." This would not have satisfied Descartes. Again, in a wider sphere, the mathematical form of modern physical relations is equivalent to that of the mathematical theory of probability. Accordingly, a physical picture is drawn to represent those relations which includes entities having a choice of states, with each of which an '*a priori* probability' is associated; and the phrase '*a priori*' is accepted as an exemption from the task of looking deeper. Instead, a 'logic of probability' is sought, which means that instead of starting with what we cannot doubt, we seek to start with what we cannot help doubting—even with doubt itself: uncertainty is made not only a principle but the fundamental principle.

Another tendency in the same direction arises from the axiomatic method of modern logic. Whereas ancient logic was merely an instrument for discovering mistakes—or rather for giving names to mistakes that were obvious—modern logic is creative: it seeks to build as large a calculus as possible from the fewest arbitrary axioms or postulates. This is excellent, and potentially of the greatest value to science, but it is not without serious dangers. When we find that to a certain department of observation a calculus of this type is applicable, the temptation to regard its axioms as 'fundamental truths' sometimes proves irresistible, and principles which it is not only possible to doubt but scarcely possible to credit become enthroned as intuitive principles of philosophy, and the observations on which they have been foisted are thought to have been deduced from them by pure reason alone. It is not difficult to imagine what Descartes would have thought of this.

It is the misfortune of Descartes that his influence was weakest where it was most needed, and where it was overwhelmingly strong our most urgent need now is to remove it. Science absorbed two things from Descartes—co-ordinate geometry and the fundamental division of existence into thought and extension—and, paradoxically, while these were essential to its progress they were alien to its nature. As a mathematical discovery, revealing the correspondence of algebra and geometry, and as a tool for the solution of problems in either, it would be impossible to over-rate the importance of co-ordinate systems. Take them away, and much of the science of the last three hundred years becomes impossible. But it is equally true to say, let them remain and much of the science of the future becomes impossible. What was not at first realized was that the arbitrariness of the co-ordinate system introduced a large element of arbitrariness into the results that were achieved by its use, and to-day, side by side with the technique of using co-ordinate systems, the mathematician has to learn the technique of finding invariants and tensors by which their influence can be eliminated. There is a sense in which Einstein's law of gravitation can be defined as what remains in the ordering of space and time measurements when the effect of co-ordinate systems has been removed. One cannot see how it could have been reached without the use of co-ordinates or without their disuse.

Much the same, though in a slightly different sense, can be said of the *res cogitans* and *res extensa*—thinking things and extended things—into which Descartes divided the realm of existence. To him the material world was something completely independent of the mind that perceived it. It had one fundamental characteristic—extension. Its other apparent qualities—colours, temperatures, sounds and so on—were merely a confused kind of knowing, ultimately mental in character, which could all be thought away from it, and he accordingly gave little attention to them. His physics was thus deprived of most of the data on which a successful physics could thrive, and the best he could do with the extended world was to fill its apparently empty spaces with an inapprehensible 'primary matter' in which vortical movements carried the heavenly bodies around in their courses. With thinking things he made no progress at all.

Galileo, on the other hand, with much less theorizing, instinctively adopted the practice which has been the hall-mark of science ever since. Instead of attributing observed motions to hypothetical motions conceived to be necessities of thought, he described them in terms of measurements made with rods and water clocks, and thus discovered the regularities that they exhibited. This was a procedure that could be developed. Newton could complete Galileo's work on motion and show the barrenness of the Cartesian vortices. Moreover, later workers could treat in the same way those very sensations that Descartes had despised. Hotness and coldness could be described in terms of measurements made with thermometers and radiometers and their regularities discovered; colours could be described in terms of measurements made with spectrometers and photometers and laws of colour formulated. Other sensations could be similarly studied, and the whole modern science of physics thus grew up as a rational correlation of sense experiences.

But while it was the Galilean practice that was followed, it was in the light of the Cartesian philosophy that it was seen. The men of science were correlating their observations, but thought they were discovering the nature of the independent, objective, extended world that Descartes had bequeathed to them. The philosophy of Descartes held the science of the eighteenth and nineteenth centuries in an iron grip, all the firmer because it was unrecognized. Berkeley had shown the hollowness of the extended things and Hume that of the thinking things, and they were unanswerable, but the mischief had been done. They might as well not have lived for all the effect they had on the ideas of the men who were making scientific history. Nor is this entirely to be deplored. It is very questionable whether the great advances of those two centuries would have been possible without the simple concrete picture of a passive extended universe of matter presented for study to independent minds. There was much to be done that could be effectively conceived in those terms, and the excesses of an over-confident materialism were perhaps not too high a price to pay for the discoveries and correlations that would otherwise have been achieved, if at all, only with much more difficulty, less general understanding, and far less speed.

It was, indeed, not until almost our own time that the Cartesian doctrine began to mislead. Experiments such as that of Michelson and Morley were the first that utterly refused to accommodate themselves to it. The facts compelled us to substitute the result of the actual process of measurement for the supposed objective extension of the arms of the apparatus, and that result was found to depend inescapably on the particular co-ordinate system in terms of which it was interpreted. The Cartesian world of extended things was seen, in fact, to be an illusion. What physics was concerned with, and always had been concerned with, were the results of its own specified operations, not a hypothetical world of dead being on which those operations were conceived to have been performed.

Such a long-standing prejudice, however, is not easy to abandon. Physics to-day is in a transition stage, in which many of its devotees, rather than abandon their Cartesian universe, are prepared to make it nonsensical by giving it contradictory properties. Others accept the relativity requirement where they must, but maintain the incompatible traditional view where they still can. Such anomalies must be expected; they will be temporary. A more portentous aspect of the new freedom is the rise of scientific psychology. Such a thing is impossible under the Cartesian scheme: thinking things cannot be related with extended things. To-day emotions and hallucinations are being studied exactly as though they were sensations or cognitions of a material world. Here the Cartesian duality is not refuted: it is simply ignored—a far more fatal treatment.

It is perhaps a melancholy thought that we can best celebrate the death of Descartes by expediting the death of his system; but there are compensating reflexions. In a world of enlarging experience no philosophy can hope to live for ever, and we can only stand in respectful admiration before one which, born at the beginning of a great new era of thought, could direct the course of that thought for two hundred and fifty years. Its passing leaves a blank which, when it is fully realized, will be seen to demand a successor, and no successor can be acceptable that does not start where Descartes started, with that which cannot be questioned. As the first clear exponent of that principle at least he is immortal.

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[1] "The Nature of the Physical World", p. 283 (Camb. Univ. Press, first edit.).

MECHANISM OF DETONATION

A DISCUSSION on "Detonation" was held by the Royal Society on November 10, in the Society's rooms, with the president in the chair. Some of the speakers described work which was done during the Second World War, while others described work which has recently been completed or is still in progress.

The discussion was opened by Dr. W. G. Penney, who described current ideas on the structure of the reaction zone. The leading edge of this zone is a strong shock front in which the pressure rises to its maximum value in a distance of order 10^{-5} cm., while at the same time the temperature rises high enough to start reactions at a very fast rate. The reaction energy may be regarded as heat supplied from an external source; and the result is to produce an expansion of the reacting material, with a fall in pressure but an increase in temperature. The width of the reaction zone is a few millimetres for most solid explosives, and the time of transit of any particle through the zone is approximately one microsecond. In most cases, the width of the reaction zone is small compared with the radius of curvature of the shock front, and the flow through the zone can therefore be regarded as one-dimensional. Conservation of momentum then leads to a linear relation between pressure P and specific volume V throughout the zone:

$$P - P_0 = D^2(V_0 - V)/V_0^2. \qquad (1)$$

The detonation velocity is D, and zero suffixes refer to undisturbed material ahead of the wave.

Conservation of energy leads to the second Rankine-Hugoniot equation

$$E - E_0 = Q + \tfrac{1}{2}(P + P_0)(V_0 - V), \qquad (2)$$

where E is the internal energy and Q the heat added from chemical reaction or from some other source.

Given E as a function of P and V, the relationship (2) gives a family of curves on a (P, V) diagram with parameter Q. Taking Q to be the total energy supplied by the reaction, then conditions at the rear of the reaction zone are given by the intersection of the line (1) with the curve (2), which is concave upwards. The Chapman–Jouguet hypothesis states, in effect, that D has the minimum possible value consistent with a real solution for P and V, that is, that the line (1) touches the curve (2). This determines D for a given Q, and it can then be shown that the particle speed at the rear of the reaction zone is sonic relative to the shock front and so equals $D - c$ relative to fixed axes.

A region of uniform conditions behind the reaction zone is possible if the product gases are contained by a piston moving with velocity $D - c$. If the piston is slowed down, then a rarefaction wave will travel forward from it with velocity c relative to the material, that is, with velocity D relative to fixed axes, and so will never catch up the reaction zone. On the other hand, if the piston is accelerated, a shock wave will travel forward at supersonic speed, run right through the reaction zone and increase the strength and the speed of the shock front. It is therefore possible in principle to increase the detonation velocity, but this will ultimately decrease again to its Chapman–Jouguet value if the piston is slowed down, since the flow behind the reaction zone is now subsonic relative to the front.

If one attempts to compute conditions throughout the reaction zone, various uncertainties in points of detail are encountered. These are most simply illustrated by considering the detonation of a gaseous mixture. The leading edge is a shock in which molecular translations and rotations assume a Boltzmann distribution, but vibrations and dissociations are relatively unexcited. Energy then passes from the translational and rotational degrees of freedom into the other modes, and chemical reactions begin. Even a rough theoretical treatment of these processes would be instructive. Such a treatment, although feasible, has not yet been attempted.

Sir Geoffrey Taylor said that in a number of special cases a similarity condition can be used to reduce the number of independent variables to one, thus allowing a numerical solution to be obtained directly. Very often there is no unit of length given by the initial conditions, and a possible solution is one in which the whole system expands uniformly with time. This similarity rule may be applied to certain detonation waves provided the reaction zone is of negligible width. He had given such solutions for the air wave caused by the uniform expansion of a rigid sphere, and for the air wave caused by the explosion of a point source of finite energy. Another similarity problem is that of a plane detonation wave started at a definite plane. The relationship between particle velocity u and sound velocity c is very nearly linear, so that u falls nearly linearly with distance behind the front until it reaches some definite value and then remains constant back to the boundary. This value is either zero or $-c$, according as the rear boundary is rigid or free. Much the same is true for a spherical detonation wave except that his solutions give infinite pressure and velocity gradients just behind the reaction zone. Another problem which reduces to one independent variable is that of the expansion of a long cylindrical case enclosing a stick of explosive. Sir Geoffrey showed a photograph which confirmed his prediction that all fragments from the wall would move in directions making nearly the same angle with the shell axis.

In the subsequent discussion Dr. S. Paterson pointed out that Devonshire had shown that the Chapman–Jouguet condition is satisfied for a spherical detonation wave at a point where the reaction is not quite complete.

Prof. H. Jones showed how P and V at the end of the reaction zone can be determined from the detonation velocity (of a plane wave) and its variation with the initial specific volume V_0 of the explosive. For a given V_0, the Chapman–Jouguet condition implies that the line (1) touches the curve (2); but if V_0 is varied, then (1) becomes a ruled surface touching the surface (2) in (P, V, V_0) space, along a line which will be continuous for physical reasons. This contact now gives two conditions, one of which is the usual Chapman–Jouguet condition, while the other leads to the equation

$$P = D^2/V_0(2 + \alpha)\,\{1 - d(\log D)/d(\log V_0)\}, \qquad (3)$$

with a similar equation for V. The only unknown is α, which must be calculated from some assumed equation of state. It can, however, be shown that α is a small positive quantity of order 0·2, so that one need estimate α to only 10 per cent accuracy in order to determine P and V within 1 per cent. An upper limit for P, not more than 10 per cent too high, can be obtained at once by setting $\alpha = 0$.

Prof. Jones also outlined his theory of the variation of velocity of detonation of a cylindrical charge with the radius R. If a stream tube near the centre of the charge increases in radius by a factor z while passing through the reaction zone of length L, then

$$(D_\infty/D_R)^2 = 1 + K\,(z^4 - 1), \qquad (4)$$

where $K \simeq 2$. One can determine z as a numerical function of L/R, and when this is small the change in D is proportional to it. Given D for several values of R, it is possible to calculate L.

Dr. W. M. Evans briefly described how detonation velocities, probably the easiest to observe among the many physical properties associated with detonation, can be measured, for example, either by the Dautriche method using 'Cordtex' or with a rotating drum or mirror camera. The latter method has great advantages over the former, and a typical camera is that developed by the Road Research Laboratory during the War, which has a rotating mirror giving a maximum writing speed of 1 mm./microsec. Considerable work has been carried out on the variation of D with factors such as density of loading, grain size, confinement and diameter, and from such observations values of L have been deduced which vary from about 1 mm. to 10 mm. for various explosives.

Among the more recent research is a study of the passage of the detonation wave from a fast to a slow explosive and *vice versa.* The camera can also give false results by recording the velocity of the air shock outside the charge. To avoid this danger, a series of holes are drilled either parallel to the axis of the charge or parallel to a radius and lined with copper tubes to keep away the air shock, and the camera records the time of arrival of the wave at the bottom of each hole. With these techniques, it was found that, for a number of pairs of cast explosives, the change in detonation velocity is completed within a millimetre or so from the interface, a result somewhat contrary to that expected and, indeed, not in agreement with those published by other observers. The work is being continued with other pairs of explosives.

Mr. C. A. Adams described an improved form of the R.R.L. camera which is now in use in the Armament Research Establishment. This employs two telephoto lenses which view the object through two slits at right angles. The mirror rotates at 40,000 r.p.m., giving a writing speed of 4 mm./microsec. At this speed it is essential to evacuate partially the camera in order to cut down wind drag on the mirror. A higher writing speed has been obtained in a single-lens camera by using a compressed air turbine to rotate a mirror at 80,000 r.p.m.

Dr. J. S. Courtney-Pratt described an apparatus which gives an equivalent writing speed of 24 mm./microsec. by forming an image on a light-sensitive screen which is scanned by a very rapidly deflected electron beam. This shows that the detonation velocity of lead azide attains its steady value in less than 5×10^{-9} sec.

Prof. R. M. Davies described work on the detonation of gas mixtures in a long tube. Pressure gauges flush with the wall and in the closed end measure the hydrostatic and reflected pressures respectively. Either a piezo-electric gauge is used or a pressure bar, with a condenser unit or strain gauge to measure the displacement of the far end of the bar as a function of time. The pressure bar using compressional waves gave poor results on account of dispersion, but considerable improvement has been obtained by using torsional waves in the bar and recording them optically. The time resolution is provided by a rotating mirror, driven by an air turbine, with a writing speed of 3 mm./microsec.

Dr. P. Bowden said that initiation usually starts at hot spots formed either by: (*a*) adiabatic compression of air bubbles, or (*b*) localized frictional effects on the containing surfaces, on grit particles or on particles of explosive, or (*c*) viscous heating. The extreme sensitivity to impact of nitroglycerine confined in a small hollow has been shown to be due to minute air bubbles, and the fact that air between the crystals contributes to the initiation of solid explosives was demonstrated by the reduction in their sensitivity with reduced atmospheric pressure. On being heated, initiators explode without melting and so are very sensitive to friction. Courtney Pratt has shown that they attain their full detonation velocity practically instantaneously. The less sensitive explosives used for bulk fillings melt before exploding and usually take some microseconds to build up to the full detonation-rate. A detonation velocity of order 2,000 m./sec. is often observed in the early stages, and extraneous factors such as grit and air bubbles probably produce an important effect here. A subsequent speaker stated that this low-velocity detonation often occurs for a short time during the fading of detonation in a charge of small diameter.

Dr. A. R. Ubbelohde stated that lead azide behaves like a less sensitive explosive if suspended in an inert liquid. He went on to say that by adding rock salt, the temperature in the reaction zone of T.N.T. can be reduced by some 500° without materially increasing the reaction time, so that activation energies must be very low. He also pointed out that many chemical reactions will proceed detonatively if the scale of the experiment be large compared with the necessary reaction-zone width. An example is the transformation from amorphous to crystalline arsenic. Another possible example is the detonation of ammonium nitrate. The width of the reaction zone is large for this material, and detonation could only occur if the quantity of material were sufficient. It is well known that small quantities of ammonium nitrate cannot be detonated, whereas several disastrous explosions have shown that it can be detonated in amounts of the order of a thousand tons. A similar example quoted by Sir Geoffrey Taylor was that of coal dust–air mixtures in long tunnels, where the reaction zone may be some 300 yd. long.

Dr. Taylor emphasized the need for a study of the detailed kinetics of the reaction zone. He said he has evidence that in the low-order detonation there is thermal decomposition in a surface reaction. The reaction zone length agrees reasonably well with rates of burning extrapolated from closed-vessel experiments.

H. H. M. PIKE

INTERNAL CONSTITUTION OF THE EARTH

A GEOPHYSICAL Discussion on the "Internal Constitution of the Earth" was held at the Royal Astronomical Society on November 25, 1949. Dr. R. Stoneley was in the chair, and, in introducing the subject, said that until the early years of the present century the only observational evidence for the internal constitution of the earth came from astronomical observations. The period of the variation of latitude, combined with a knowledge of the value of the precessional constant, gave a mean rigidity for the whole earth approximately equal to that of steel. No information on the internal distribution of rigidity, or of density, was available. The so-called laws of density of Laplace and Roche were merely assumptions of suitable mathematical form to render certain differential equations, involved in calculating the figure of the earth, more easily soluble. Wiechert's hypothesis, propounded in 1897, was the first to be based on physical reasoning. He supposed there was an iron core to the earth of density 8·2 (all densities in gm. per c.c. throughout this article) and radius 0·78 of that of the earth, the remainder having mean density 3·2. He arrived at it by considering the composition of meteorites. Any hypothesis must agree with the value of the moment of inertia of the earth, 0·334 Ma^2 (where M is the mass of the earth and a its radius), derived from the precessional constant and the theory of the figure of the earth. This value taken by itself gives evidence of a concentration of density towards the centre, since the value for a homogeneous sphere would be 0·4 Ma^2. More detailed evidence has been obtained since then from the times of arrival of the various pulses received from earthquakes. It was found by Gutenberg that a core of radius 0·545a would agree with seismological results. However, Prof. H. Jeffreys was able to reconcile the difference between this value and Wiechert's by taking into account the effect of compressibility. The failure of the core to transmit S-waves is evidence of its being liquid. From the complete travel-time data, it is possible to determine uniquely the velocities of P- and S-waves as functions of the distance from the centre.

To obtain the density distribution a further assumption must be made, namely, that in between the major discontinuities the earth is chemically homogeneous, and that the increase of density within each layer is solely due to the compressibility. In this way a differential equation can be set up and integrated numerically, as was first done by Adams and Williamson and later in more detail by Prof. K. E. Bullen[1]. The solution obtained indicates a fairly steady increase of density in the mantle from about 3·3 near the surface to about 5·8 near the core, with a large discontinuous jump at the core to a value of about 9·6, values as high as 12 eventually being reached towards the centre of the earth. There is good evidence for the existence of an inner core of yet higher density within the main one, and rather uncertain evidence that this is rigid.

Mr. H. Bondi described a paper by Kuhn and Rittmann[2] in which the authors adopt a radically new approach to the problem of the interior of the earth. Instead of starting, as in most other theories, from the known physical data, they begin with the theory of the origin of the earth and discuss the developments that would follow during the ageing of the earth. Only after a model of the earth has been constructed in this way do they examine whether its physical properties are compatible with the geophysical data. Unfortunately, this interesting and original approach is marred by the fact that the authors base their views on cosmogonical ideas which are widely considered to be wrong. They assume that the earth once formed part of the sun, although there is no evidence for, but a good deal of evidence against, such an assumption. Secondly, they assume that hydrogen formed only about 30 per cent of the mass of solar material, whereas now there are good reasons for believing that more than 98 per cent of the mass of the sun consists of hydrogen. In the face of these changes in cosmogony and astrophysics, the theory loses much of its force.

The authors then consider the development of an earth originally containing about 30 per cent of hydrogen as well as a considerable proportion of other light elements. All these escape readily from the surface of the planet, but not from the interior owing to the slowness of diffusion. Convection currents relieve the outer layers of most of their hydrogen, and are also supposed to enrich them in radioactivity, and finally the outer crust solidifies and thereby makes any further escape of gas very difficult. In this way the authors arrive at a model of the present-day earth consisting of a thin (70 km.) crystalline crust enclosing a liquid region, highly viscous and poor in hydrogen in its outer parts (down to about 2,700 km. depth), but consisting of almost unchanged 'solar' material near the centre.

This model can be reconciled with the seismic data by consideration of the variation of the relaxation time of the liquid interior with depth. The authors claim that down to about 2,900 km. the relaxation time is so long (about 1 year) that the liquid behaves like a solid with respect to earthquake waves; but lower down, the presence of the highly mobile hydrogen atoms reduces the relaxation time to a fraction of a second, so that transverse waves are no longer propagated. Similarly, the jump in the velocity of longitudinal waves and the high central density are ascribed to the presence of hydrogen in the deep interior. It is necessary to postulate a diminution of bulk modulus as well as the loss of rigidity at the boundary of the core.

Dr. W. H. Ramsey described an entirely new theory of the interior of the earth which he himself has advanced recently[3]. He believes that the jump in density at the core boundary represents, not a change in chemical composition, but a special kind of phase-transition in a single substance. Ordinary phase-transitions usually involve small density changes, because only a rearrangement of molecules is concerned; in this case it is to be supposed that the atoms or molecules are broken up by the change. With indefinite increase of pressure, successive transitions of this kind will result in the material ending up as a Fermi gas. As an example, Dr. Ramsey cited solid hydrogen, which, it has been calculated, will change from H_2 to a 'metallic' phase, H, in which it resembles in properties the alkali metals, at a pressure of $0{\cdot}8 \times 10^6$ atmospheres. The density increases from 0·35 to 0·77 by the transition. Thus, if a large mass of hydrogen were a suitable model for a planet, it would possess a dense metallic core and a less dense outer mantle with non-metallic properties. Other elements, notably tin, arsenic and phosphorus, are capable of existing under experimentally attainable conditions in metallic and in non-metallic phases, the latter being much less dense. (For example, metallic arsenic has density 5·1, non-metallic, 2·0.)

The best test of the theory is to calculate the mean densities of the other planets, assuming all of them to be of similar chemical composition to that of the earth. The results are in gratifying agreement with the theory, except in the case of Mars. Taking account of the effects of a possible concentration of small quantities of the heavy elements towards the centre of the earth has considerably reduced this discrepancy.

Another feature of the theory is that it can account for the anomalies in the velocity distributions found just outside the boundaries of the cores. The increase in the *P*- and *S*-wave velocities with depth is arrested about 100 km. outside the outer core, so that they are about 1 per cent less at the boundary than they otherwise would be. A similar, but more pronounced, anomaly occurs for *P* just outside the inner core. In the mantle the metallic phase can exist as an excited state; the excitation energy is about 6 eV. per molecule, which can be calculated from other empirical data. This excited state is referred to as a conduction band. Similarly, in the core, the non-metallic phase can exist in an excited state; but the excitation energy in this case is found to be 24 eV. per molecule. At the temperatures likely to prevail, kT (Boltzmann constant times the absolute temperature) is about 1 eV. Hence, although in the core the chance of a molecule changing into the non-metallic phase is only exp-24, in the mantle the chance of a molecule being excited into the metallic phase is exp-6, or an appreciable fraction of one per cent. The effect is thus to produce a small amount of a mixed phase at the base of the mantle in which the bulk modulus (and also the rigidity) is reduced below that for 'pure mantle' by something of order one per cent. The negligible probability of a mixed phase occurring on the other side of the boundary explains why the discontinuity is so sharp.

The theory is also more reasonable in its predictions of the chemical composition of the earth. The ratio of iron to stony meteorites is at most 1/36, and the percentage of iron by weight for all meteorites at most 25, whereas the core of the earth contains 40 per cent of the total mass. Moreover, the inner core presents a difficulty on the ordinary view. If it is a different chemical substance from the iron of the outer core, it must be denser than iron. No abundant element can be found to fulfil this condition. On the present theory, the inner core would be interpreted as a second-phase transition, another step on the way towards the Fermi gas.

Dr. Ramsey concluded by explaining why he differed from Prof. Bullen's view, that the compressibility of materials is independent of chemical composition at the pressures prevailing in the earth[4]. It is well established that density is independent of chemical composition at the very high pressures prevailing in white dwarf stars. Density at these pressures depends only on the ratio of atomic weight to atomic number, which is about 2 for most elements. Considering the extreme cases of deuterium and gold, the former is already a Fermi gas of density 2 at a million atmospheres and will undergo no further transitions with increasing pressure, whereas the latter has density at least 30 at this pressure and may possibly increase at higher pressures. Hence, if the density of deuterium ultimately becomes the same as that of gold, their compressibilities must be very different at pressures above a million atmospheres. Bullen framed his hypothesis because of the similarity of the pressure–compressibility relationships in the core and mantle, which he assumed to be chemically distinct. But this similarity is seen by the present theory to be due to the fact that they are chemically identical. His hypothesis, suitably modified, can be taken over into the present theory without inconsistency.

The third speaker, Prof. H. Jeffreys, began by pointing out an alternative way of escape from the difficulties of explaining the wide differences of density among the planets, even if one does want to grant the principle of uniformity of composition of the universe. This is by using Lyttleton's theory[5] that the planets developed in two stages, a core forming within each parent planet during the first stage, and then each parent breaking up into smaller ones due to excessive rotation afterwards. Prof. Jeffreys thought this theory mechanically possible, and it would easily explain why the planets in the solar system are so heterogeneous.

Commenting on Kuhn and Rittmann's theory, he said that they appear to have overlooked the importance of convection, and have calculated the rate of loss of hydrogen from the original ball of solar material solely from the ordinary laws of diffusion. Evidently convection must play an important part, because the earth has succeeded in getting rid of its heat and solidifying, at least in the outer parts. In any event, if their theory that the cooling planets retain their hydrogen were correct, the larger planets would be denser because of the greater pressure inside. In fact, for example, the density of Jupiter is only one-quarter that of the earth. Another important basic assumption in their argument is that the crust of the earth solidified in a few thousand years. The possible screening of the surface of the earth by a dense atmosphere of steam could have prolonged the cooling by a factor of a thousand or so. This would have given ample time for the escape of hydrogen without being an appreciable fraction of geological time.

Turning now to the arguments for and against the existence of an iron core, Prof. Jeffreys went on to cite an objection lodged by A. Eucken, who pointed out that since silicon has a high boiling point, one would expect it to find its way into the core. This could be dealt with by supposing silicon hydride to be formed first, and the gaseous envelope of this material to be oxidized to silica by the water present at a later stage, and the hydrogen lost. Positive points in favour of an iron core are that it gives the right density and explains why it is liquid, and would be expected to give a sharp transition. Prof. Jeffreys emphasized that seismological evidence shows that the transition must occur within an extremely short distance, of the order of a few kilometres.

The first point in favour of Dr. Ramsey's theory is that, at the enormous pressures prevailing, a chemical change implying even only 2 per cent decrease in specific volume would be bound to take place. But the theory, as developed so far, is purely qualitative and does nothing to predict at what pressure the transition should occur, what the change of density would be, or why the metallic phase is liquid. It does, however, explain why the boundary of the core is sharp and why the densities of Venus and the earth differ so much more than expected from their difference in size. Ramsey's theory of the instability of small cores[3] leads to the result that at a certain critical size a slight change of mass could produce large changes of density. Calculations show that Venus and the earth are not far above that critical size.

Coming finally to the question of the small anomalies in the *S*- and *P*-wave velocity distributions just outside the core, Bullen has endeavoured to explain these by a concentration of denser materials, keeping to the idea that the compressibility is a function of pressure only for all substances. So far, no likely substance has been found which could give the required concentration of density. Ferrous sulphide and fayalite have been suggested, but the former has been excluded because the sulphur atoms are so large, and the latter because fayalite crystallizes last from an olivine magma and would hence be expected to appear on the outside of the mantle, not on the inside.

In the ensuing discussion, considerable interest was displayed in Dr. Ramsey's new theory, and in response to questions he added the following remarks. The argument for the existence of iron cores to all the planets because iron meteorites are found is not very forceful; there is no reason why there should not be local concentrations of iron in planets with structures following Ramsey's scheme, and that could account for all the iron meteorites found, if indeed the exploded planet theory of their origin is acceptable. In several respects the theory requires no serious changes in existing views on the properties of the interior. The conductivity of the metallic phase is likely to be of a similar order of magnitude to that of iron; the conductivity of metallic hydrogen, for example, has been calculated to be about forty times that of silver under normal conditions. There is, therefore, no immediate need to review the theories of the magnetic field of the earth put forward by Elsasser and Bullard. The inner core would be expected to be rigid on this theory for much the same reasons as on Bullen's. Knowledge of the temperatures in the interior of the earth is very uncertain, and Ramsey's theory could hold provided that the temperatures lie in the range, say, 10,000–30,000° K., which, so far as is known at present, would be quite possible. There is no apparent mechanism for concentrating the radioactivity of the earth in its upper layers, since no chemical sorting need be supposed to have occurred. However, the basis of the conclusion that this has, in fact, taken place is the assumption that the earth has been cooling ever since its formation. There seems no real need for this assumption, since the heat generated internally by a uniform distribution of radioactivity of the same density as is found for meteorites would not have brought about an inadmissible rise of temperature in geological time. R. I. B. Cooper

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[1] Bullen, K. E., "Introduction to the Theory of Seismology" (Cambridge University Press, 1947).

[2] Kuhn, W., and Rittmann, A., *Geol Rundsch.*, **32**, 215.

[3] Ramsey, W. H., *Mon. Not. Roy. Astro. Soc.*, **108**, 406 (1948); and *ibid., Geophys. Supp.*, **5**, 409 (1949).

[4] Bullen, K. E., *Mon. Not. Roy. Astro Soc., Geophys. Supp.*, **5**, 355 (1949).

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OBITUARIES

Dr. Clifford Dobell, F.R.S.

With the passing of Clifford Dobell on December 23, 1949, science has lost a notable worker in the field of protozoology, one who has made important additions to our knowledge in human and comparative parasitology.

Dobell was born in 1886 and educated at Sandringham School, Southport, proceeding later to Trinity College, Cambridge, where he had a brilliant career. Commencing with his graduation as B.A. with first-class honours in the Natural Sciences Tripos in 1906, he was eventually awarded the Sc.D. in 1942. He was elected a fellow of Trinity College in 1908 and during 1908 and 1909 held the Balfour Studentship at Cambridge. He was awarded the Walsingham Medal of the University and was Rolleston Prizeman, Oxford and Cambridge, in 1908.

At Cambridge, Dobell was a pupil of that great zoologist, Adam Sedgwick, and in his classical monograph on the life-history and chromosome cycle of *Aggregata eberthi*, he pays a sincere and graceful tribute to the debt he felt he owed to his former master. The materials for this study were collected chiefly at the Zoological Station in Naples in 1908 and in Monaco in 1913.

Early in his career Dobell was attracted by the parasitic Protozoa, and it is in this field that he made his most notable contributions to science. His growing reputation led, in 1910, to his appointment as assistant professor of protistology and cytology at the Imperial College of Science and Technology, London, where he remained until 1919. Here he carried further his researches on the parasitic Protozoa of animals and continued his study of the materials previously collected at Naples and Monaco.

Dobell was now fully equipped, in knowledge and experience, to turn his energies to the study of the human intestinal Protozoa, in which he never afterwards lost interest and on which he became a world authority. His work had special application during the First World War, when he was responsible for the training of protozoologists, especially in connexion with the most important application of protozoology under war conditions, the diagnosis of infections of *Entamœba histolytica*. At this period, he made a close study of the human parasitic amœbæ from the aspects of morphology and classification, and was also one of the workers chiefly responsible for the improved methods of treatment with emetine evolved at that time. In 1918, he was elected a fellow of the Royal Society in recognition of his outstanding work, while in the following year he produced his second classic, "The Amœbæ Living in Man", a work still constantly consulted in clinical and research laboratories.

Dobell now joined the National Institute for Medical Research as protistologist, and this Institute was the scene of his labours for the rest of his life. Here he continued his work on *Aggregata eberthi* and his studies on the human intestinal Protozoa, the results of the latter studies being embodied in the important publication (with F. W. O'Connor) in 1921, "The Intestinal Protozoa of Man". About this time he made comparative studies of the amœbæ of man and macaque monkeys, in which he claimed to have established the identity of the species in these primates.

No account of Dobell's work would be complete without a tribute paid to his masterly study, "Antony van Leeuwenhoek and his 'Little Animals'". This must be considered one of the very great books connected with the study of natural history. Apart from its intrinsic interest and importance as a record of the work of the 'father of protozoology', its compilation from original sources of three hundred years ago was obviously a labour of love to the author. Imagine the application and assiduity of the man who, to complete it, had not only to learn a foreign language in order to study original documents but also had to familiarize himself with the more or less archaic form of that language as it was written three centuries ago. All will admit that the book is a monument to the author as a great research worker and a great scholar.

Dobell in all his scientific work was meticulous and accurate. His quality as a writer and scholar was not all expended on his literary masterpiece referred to above but was also evident in his scientific publications. In his human contacts he was a curious medley. His wide learning attracted to him many workers in search of the assistance he could give, and to those whom he considered worthy he gave generously; but he could not, and would not, suffer fools gladly. His interests were almost wholly scientific and within his own field his knowledge was extraordinary, so that an afternoon spent with him was always worth while and usually amusing. His sense of humour, unsuspected by many, is evidenced in some of his lighter writings, such as his satire on the mythical Dr. O. Uplavici (translated from the Czech "On Dysentery!"), who haunted medical literature for fifty years as an author (!), and his protests against illogical and ignorant scientific nomenclature in "On Teranympha and other monstrous Latin Parasites".

Dobell and his work will occupy a permanent place in the annals of protozoology. H. E. Shortt

Dr. T. Lewis Bailey

Dr. T. Lewis Bailey, chief inspector of alkali, etc., works, Ministry of Health, during 1920–29, died at Redhill from heart failure on December 13, at the age of eighty-five.

Dr. Bailey was appointed sub-inspector of alkali works in 1908 and for five and a half years was in charge of the South Wales district, acting as assistant to Dr. Fryer. In these years he had a wide experience of the various industries in the West Country, including tinplate manufacture in South Wales and arsenic production in Cornwall. During this period the problem arising from atmospheric pollution by tinplate flux works was satisfactorily solved. In 1914 he succeeded Mr. Ballard as inspector in south-west Lancashire, North Wales and Ireland. In 1920, on the retirement of Mr. Curphey, he was appointed chief inspector.

During his tenure of office Dr. Lewis Bailey devoted much time to the question of effluents from ammonia plants, and in this connexion he was led to consider the whole process of coal gas purification with the view of providing an ammonia liquor of a less noxious character. He also took particular interest in the subject of water scrubbing on Gay Lussac tower gases as a means of reducing the acidity of sulphuric acid plant escapes, and in the elimination of sulphur oxides from waste gases arising from the combustion of fuel. He was an original member of the Government Chemist Committee under the chairmanship of the late Sir Robert Robertson which was charged with the examination of proposals for gas washing at the Battersea Power Station.

In 1929 he retired on reaching the age of sixty-five years, and from that time had lived quietly in south-east England.

Prof. W. S. Lazarus-Barlow

PROF. LAZARUS-BARLOW, whose death occurred on January 15, was one of the earliest experimental pathologists in Great Britain to turn his attention to cancer.

After filling pathological posts at Cambridge, St. George's and Westminster Hospitals, where a post-mortem snick of the thumb led to the loss of his left arm, Lazarus-Barlow was made director of the Cancer Research Laboratories of the Middlesex Hospital. Fifty years ago, these Laboratories consisted of about eight small rooms on the ground floor, packed to capacity by men and women drawn to the twofold problem of the cause and cure of cancer. Lazarus-Barlow saw that with the growth in the use of X-rays and radium there was an urgent need for fundamental knowledge of the effects of these agents upon living structures, so he and his colleagues took up experimental studies upon these vital reactions of the cell: and it was found that a living cell exhibits much greater sensitiveness to radiation when it is in a state of active division than when in its growing phase. Lazarus-Barlow in particular showed the differential response of tissues according to whether the radiation dose is given in a short or a long period of time (QT – constant). Such a finding had an obvious bearing upon the radiation treatment of cancer. As early as 1909 he gave the Croonian Lectures of the Royal College of Physicians, choosing the subject of "Radioactivity and Carcinoma".

In view of the widespread occurrence of radium in Nature, it is not perhaps surprising to find it present in organic life. By strictly quantitative methods, Lazarus-Barlow showed the presence of radium in normal and malignant tissues, and that a pre-cancerous condition can be set up by a prolonged exposure of animal tissues to gamma-rays.

Lazarus-Barlow was a fine exponent of his subject and a writer who served the needs of many students of pathology. His two chief books were "A Manual of General Pathology" (1898) and "The Elements of Pathological Anatomy and Histology for Students" (1903).

Margaret R. Shackleton (Mrs. F. G. Mann)

THE death of Margaret Shackleton at Cambridge on January 26 will come as a shock to her many former students of University College, London, where she assisted the late Prof. L. W. Lyde in building up the Honours School of Geography from 1920, soon after the courses were begun. Shortly after her marriage she published her deservedly popular "Europe: a Regional Geography" (1934), of which she had just completed a thorough revision for the fourth edition at the time of her death. She returned to lecturing in Cambridge during the War, to students evacuated from Queen Mary College, London, and was actively engaged on research into demographic problems of the Danubian lands.

L. D. S.

NEWS and VIEWS

College of Aeronautics, Bletchley: Mr. A. D. Young

MR. A. D. YOUNG has been appointed to the chair of aerodynamics in the College of Aeronautics, Bletchley, in succession to Prof. W. J. Duncan, recently elected Mechan professor of aerodynamics and fluid mechanics in the University of Glasgow (see *Nature*, November 26, 1949, p. 905). A graduate of the University of Cambridge, Mr. Young spent a year in postgraduate research at the University Aeronautics Laboratory and then joined the Aerodynamics Department of the Royal Aircraft Establishment. He remained there until he went to the College of Aeronautics in 1946, where he is at present deputy head of the Department of Aerodynamics and senior lecturer in aerodynamics and gas dynamics. While at the Establishment he covered a wide range of experimental research, with some emphasis on flaps and other high-lift devices and on the general problem of stalling. He carried out experiments in the high-speed tunnel, particularly on tunnel-wall interference and on roughness effects. Mr. Young was also responsible for much full-scale research, including measurements of the drag of laminar-flow wings in flight. But his best known and most fundamental research work has been in the application of theory, first to the study of the boundary layer and the cognate problem of skin-friction at low speeds and later the extension of such theory to problems of compressible flow. In this field he is an acknowledged authority.

Standard Frequency Transmissions from Great Britain

IN 1948 the Department of Scientific and Industrial Research announced that arrangements were being considered for an experimental service of standard-frequency radio transmissions from the United Kingdom (see *Nature*, 162, 269; 1948). A committee under the chairmanship of Dr. R. L. Smith-Rose established the need for such a service, and at the request of the Department the General Post Office assumed technical responsibility for the transmissions, which are taking place from the Rugby radio station.

The service began on February 1 on the following three frequencies, each being transmitted at a power of 10 kW.: 0544–0615 (hours G.M.T.), 5 Mc./s.; 0629–0700, 10 Mc./s.; and 1029–1045, 60 kc./s. Each transmission is modulated in accordance with a fifteen-minute cycle, where applicable, at the following minutes past the hour: 59–00, 14–15, 29–30 and 44–45, slow morse call sign *MSF*, followed by a speech announcement; 00–05, 15–20, 30–35 and 45–50, carrier-modulated with 1,000-c./s. tone; 05–14, 20–29, 35–44 and 50–59, unmodulated carrier. It is proposed to add in due course 1-c./s. pulses during the first five minutes of each period at present unmodulated.

The transmissions on 60 kc./s. should be received throughout the United Kingdom and Western Europe and enable local standards to be calibrated with high precision; those on 5 and 10 Mc./s. form part of an international programme designed to give reliable world cover on one or other of the frequencies, 2·5, 5, 10, 15, 20 and 25 Mc./s., which have been allocated to standard frequency services. The transmissions on these frequencies from the United States National Bureau of Standards station *WWV* are not always satisfactorily received in the United Kingdom and farther east. It is hoped to learn from the experimental service now being initiated to what extent reception in the European area is improved by transmissions from the United Kingdom, and also to what extent the usefulness of both the American and the British transmissions may be impaired by mutual interference. The frequencies, which are to be maintained within two parts in one hundred million of the nominal values, will be monitored at the National Physical Laboratory, and all inquiries or comments concerning the transmissions should be addressed to the Director, National Physical Laboratory, Teddington, Middlesex. Information about reception conditions and interference with the United States transmissions will be particularly useful.

Centenary of the Royal Meteorological Society

THE centenary of the Royal Meteorological Society falls on April 3, and the following provisional programme in celebration has been arranged. A series of scientific symposia will be held at Christ Church, Oxford, in which a number of eminent foreign meteorologists will participate. The symposia at Oxford will be: March 28 (afternoon), radiation and its effect on the troposphere and lower stratosphere; March 29 (morning), physics of clouds and precipitation; (afternoon), structure of weather systems; March 30 (morning), general circulation of the atmosphere; (afternoon), climatic change; March 31 (morning), meteorology and the community. The meeting at Oxford will terminate with a tour of the city on the afternoon of March 31 and a theatre party in the evening. On April 1 an excursion will be made to the Meteorological Office, Harrow, and at 8 p.m. a conversazione will be held in the Society's Rooms at 49 Cromwell Road, London, S.W.7. A visit to the Department of Meteorology, Imperial College of Science and Technology, will be made on the morning of April 3, and at 3 p.m. the main centenary meeting will take place in the Society's Rooms. In the evening, at 7.45 p.m., the centenary dinner will be held at the Connaught Rooms, London, W.C.1. Accommodation is available at Christ Church, Oxford, and afterwards during April 1–4 at Bedford College, London. To mark the occasion, a special meteorological exhibition is being arranged at the Science Museum, South Kensington, London, S.W.7, and will be open for three months from March 27. Further particulars can be obtained from the Assistant Secretary of the Society.

The Man of Science in Society

DISCUSSING the role of the man of science in society, a writer in the October 1949 issue of *Endeavour* supports the views of those who believe that, outside the laboratory, the personal influence of the man of science should be no more than that of any other citizen, against those who advocate a state verging on a technocracy in which men of science would have special privileges and a large measure of control. Despite his training in scientific method and his ability to store technical information and to interpret it, the man of science is but a link in a long chain and is no more indispensable than other links which support him. There are administrative and economic factors of which the man of science usually knows very little. The majority of men of science—and the informed lay public—feel that science has only limited use in the solution of problems largely influenced by emotional and other imponderable factors. Human problems can only be solved by the accumulated wisdom of responsible laymen who interpret such problems in the light of long and varied experience in human relations and which, until we know vastly more than we do to-day about the working of the human mind, can only be described as intuitive. To make the best use of science there is need for numbers of men of a type which to-day is scarce but not unknown—those who have had a thorough scientific education but have also had considerable experience in practical affairs.

Exchange of Diagrams and Data between Radiation Therapy Centres

THE scheme, organised by the Hospital Physicists' Association, for the exchange of useful diagrams and data between radiotherapy centres is discussed in the *British Journal of Radiology* (February, 23, 139; 1950). Most centres accumulate isodose and other charts, nomograms, machine drawings and tabulated data, which would often be useful to many other centres, and diagrams in the literature are generally too small to be of practical use, whereas large copies of the originals might be useful. Therefore, catalogues have been issued by the Hospital Physicists' Association, describing all the material available of which copies can be supplied by the honorary secretary of the scheme. Catalogue *A*, issued in December 1944, contained 213 items, and Catalogue *B*, of June 1946, more than two hundred. By the end of 1949 the inquiries about the scheme and requests for catalogues showed no signs of abatement, and about four hundred copies of the first two catalogues had been distributed to all parts of the world. The total number of diagrams, etc., now distributed exceeds 2,500—45 per cent of which have gone outside Great Britain. Within a single recent period of twelve months, nearly nine hundred items were dispatched. The scheme has been run so that it is just self-supporting financially, and costs have been reduced to an average of 3*s*. 2*d*. for a negative copy of a diagram and about 2*s*. for a paper copy of an X-ray isodose chart. The Hospital Physicists' Association will demonstrate the working of the scheme at a stand in the Scientific Exhibition Section of the forthcoming Sixth International Congress of Radiology which will be held in London in July. Catalogue *C*, with 270 items classified by the system used previously, was issued in December 1949, and copies can be obtained (5*s*., post free) from the present honorary secretary of the Diagrams and Data Sub-Committee of the Hospital Physicists' Association, D. E. A. Jones, Mount Vernon Hospital, Northwood, Middlesex.

Moa Discoveries

THE Association of Friends of the Canterbury Museum, Christchurch, New Zealand, has produced an interesting guide-book describing how in 1937 moa bones were found at Pyramid Valley, fifty miles from Christchurch, and how the site has since been developed. After two years excavation the total of more or less complete and clearly individual moa skeletons stood at fifty, 17 of them being *Dinornis maximus*, 3 *Pachyornis elephantopus*, 3 *Euryapteryx gravis*, and 27 *Emeus crassus*; these are the heavy-limbed giant grazing moas. In addition to bones were found remains of still undigested meals with recognizable seeds and severed lengths of twigs and coarse grasses, closely packed among the gizzard stones. The few crops examined have revealed no traces of the koromiko (Hebe), the widespread shrub universally associated with the moa in Maori legend. On an average, each gizzard contained 220 stones weighing 5½ lb. These discoveries have been of great assistance in clarifying the systematics of the moas. Copies of the well-illustrated guide may be obtained from the Museum, price 2*s*. 6*d*.

Rock-Shelter Art in South Africa

THE June 1949 issue of the *South African Archæological Bulletin* contains, among other articles, one by the Abbé Henri Breuil on "Some Foreigners in the Frescoes on Rocks in Southern Africa". The Abbé Breuil is convinced that a number of the human beings figured in rock-shelters belong to non-African races, presumably prospectors who came to explore the country. At various periods such prospectors, coming from the north, did penetrate parts of Africa, and we have accounts of them. But whether they really penetrated so far as South Africa is a real problem. The paintings at Impey's Cave certainly recall others found in a rock-shelter in North Africa. But has enough study been given to Bantu art and its possibilities? In this connexion, the studies of Canon Edward Paterson of Cyrene, Southern Rhodesia, who deals with a number of Bantu children, should be mentioned. He maintains that white-man influence has played no part in their drawings, yet these are extremely varied and sometimes quite naturalistic. The same number of the *Bulletin* contains a note, written by A. J. H. Goodwin, of a painted fishing scene from East Griqualand; fishing scenes are none too common in this art. There is also a note by R. J. Mason on some glass implements with Wilton associations.

Scientific Manuscripts from Scandinavia

THROUGHOUT Scandinavia most original scientific work is now published in the English language. Some authors write in English and others have their work translated locally; but in many cases it is advisable to obtain the services of an English-speaking man of science to check the manuscript. A most desirable course would be for such material to be checked by an English-speaking specialist who is working on almost identical lines and thereby has a natural interest in the work. The British Council has, therefore, initiated a scheme whereby it will endeavour to place each manuscript which has been submitted through its offices in Scandinavia with a scientific worker in Great Britain who is likely to have an interest in the subject in question and can carry out the checking. In general, the Scandinavians are willing to pay reasonable fees for such services, and the British Council has arranged to undertake the currency conversion for payment in sterling. The Council itself will make no charge for its services.

East African Industrial Research Board: Report for 1948

THE sixth annual report of the East African Industrial Research Board (pp. 12; Nairobi, 1949; 1*s*. 6*d*.), which became a department of the East African High Commission on January 1, 1948, covers the year ended December 31, 1948. Investigations continued on various branches of ceramic technology, such as bricks and roofing tiles, domestic pottery and refractories, the extraction of undried pyrethrum flowers, the processing of silico-phosphatic fertilizers and the treatment of waste waters from the decortication of sisal. The polluting character of the waste waters and the size of biological filter required to treat them have been considerably reduced by dry decortication of the leaf and then washing the fibre alone. Promising results have been obtained in the treatment of waste waters from processing coffee. A list of technical publications is appended.

"Mercury Tube Effect"

REFERRING to the communication under this title by Dr. J. O'M. Bockris and Dr. R. Parsons in *Nature*, 160, 232 (1947), Prof. William MacNevin, of the Ohio State University, and Earl W. Balis have directed attention to a paper of theirs entitled "Deviations between Observed and Calculated Polarographic Diffusion Currents" (*J. Amer. Chem. Soc*., 65, 660; 1943). This contains a brief reference to the effect discussed by Messrs. Bockris and Parsons.

Conference on the Older Stone Ages

A CONFERENCE on "The Older Stone Ages: Recent Trends and Discoveries" will be held by the Prehistoric Society, in collaboration with the Institute of Archæology of the University of London, at the latter's address at Inner Circle, Regent's Park, London, N.W.1, during April 14–16. A number of papers will be read, and included in the programme will be discussions on "Geographical Aspects of the Older Palæolithic Cultures", in which Dr. C. McBurney, Mr. M. C. Burkitt, Mr. H. Kelley, Dr. K. Oakley and Mr. A. D. Lacaille will participate, and on "The Origin of the Upper Palæolithic in Europe", which will be introduced by Mr. A. D. Lacaille. Further particulars can be obtained from the London Secretary, Mr. J. W. Brailsford, at the Department of British Antiquities, British Museum, London, W.C.1.

Illuminating Engineering Society: Summer Meeting

THE Illuminating Engineering Society will hold its summer meeting at Buxton, Derbyshire, during May 16–19. The technical papers will all be of a practical nature, and, in addition, two addresses will be given: by Dr. L. A. Sayce, of the Light Division of the National Physical Laboratory, on "Visual Deception"; and by Mr. Ivar Folcker, chairman of the National Illumination Committee of Sweden and president of the Swedish Illuminating Engineering Society, who will speak about lighting in Sweden during the past ten years. Further details can be obtained from the Secretary, Illuminating Engineering Society, 32 Victoria Street, London, S.W.1.

Aslib Winter Meeting

THE winter meeting of Aslib will be held at the Institution of Electrical Engineers (Savoy Place, London, W.C.2) on March 8, at 5.30 p.m., under the chairmanship of Mr. L. J. F. Brimble. Mr. F. C. Francis, of the British Museum, will speak on "The British National Bibliography", and Mr. W. Cox, of H.M. Stationery Office, on "Government Publications with Special Reference to the Card Index Service". Discussions will follow. The meeting is open to members and guests.

Conference on Mental Health and the Family

A CONFERENCE on "Mental Health and the Family" has been organised by the National Association for Mental Health and will be held at Seymour Hall, Seymour Place, London, W.1, during March 23–24. The conference will be opened by the Archbishop of Canterbury. The topics for the four sessions are: social health in the twentieth century; mental health in young children; education and mental health (childhood and adolescence); on the assumption of maturity. Tickets of admittance (including the printed report) cost 25*s*. and can be obtained from the Conference Secretary, 39 Queen Anne Street, London, W.1.

Conference on World's Food and Britain's Needs

THE Association of Scientific Workers is holding a conference on "The World's Food and Britain's Needs" at St. Pancras Town Hall, Euston Road, London, W.C.1, during March 4–5. Lord Boyd Orr will preside. The conference is designed not merely to direct attention to the urgency of the food problem, but also to show how it can be tackled scientifically. The programme will be divided into three sessions, with speakers and their subjects as follows: Session 1, Dr. Julian S. Huxley, "Population Problems", and Mr. F. Le Gros Clark, "The World's Food Problems"; Session 2, Sir George Stapledon, "Britain's Needs and Possibilities", Dr. G. A. Reay, "Fish Utilization", and Mr. S. A. Barnett, "Prevention of Food Losses"; Session 3, Mr. Ritchie Calder, "Food from Waste Materials", and Lord Boyd Orr, "World Resources and the Distribution of the World's Food". The conference will open with the showing of the documentary film "The World is Rich", by Paul Rotha, and will end with a résumé by Mr. F. Le Gros Clark, entitled "Conference Survey and Future Action". The delegation fee to the conference is 10*s*. per delegate; visitors' tickets are 2*s*. 6*d*. per session, obtainable from the General Secretary, Association of Scientific Workers, 15 Half Moon Street, Piccadilly, London, W.1.

International Congress on Analytical Chemistry

AN International Congress on Analytical Chemistry will be held in Great Britain in 1952. At the meeting of the International Union of Pure and Applied Chemistry in Amsterdam in September, it was decided that six autonomous sections should be formed, one of which would be concerned with analytical chemistry; and it is hoped that a meeting of the board of this provisionally constituted section on analytical chemistry may be arranged to coincide with the Congress in Britain. The honorary secretary of the Congress is Mr. R. C. Chirnside, Research Laboratories of the General Electric Co., Ltd., Wembley, Middlesex.

Nuffield Foundation Awards in Dentistry

To help the advancement of teaching and research on dental health and disease, the Nuffield Foundation is offering a number of fellowships to enable selected men and women with dental qualifications to receive additional training in pure and applied science that will fit them for an academic career in dentistry, and also to enable selected university graduates in medicine and science to receive training that will qualify them to undertake teaching and fundamental research on dental health and disease; in the latter case, however, it is not expected that every fellow will necessarily study to obtain a registerable dental qualification. The annual value of such fellowships is £500–800, and they will be awarded for one to three years. Scholarships, normally tenable for one year, are also available for students at university dental schools in the United Kingdom; these scholarships cover tuition fees and include a subsistence allowance of value not more than £200 a year. Application forms for fellowships must be returned by March 31, and for scholarships by June 30; the forms are obtainable from the Secretary of the Nuffield Foundation, 12 and 13 Mecklenburgh Square, London, W.C.1.

Announcements

M. ANTOINE LACASSAGNE has been elected an *académicien libre* of the Paris Academy of Sciences in succession to the late M. Gustave Roussy.

THE thirty-fourth Guthrie Lecture of the Physical Society will be given by Prof. G. I. Finch at 5 p.m. on March 3 at the Science Museum, Exhibition Road, South Kensington, London, S.W.7. Prof. Finch is the immediate past president of the Physical Society and is well known for his work on electron diffraction. The Lecture, entitled "The Sliding Surface", will be a discussion of the phenomena of wear and lubrication at the sliding surface.

THE following appointments in the University of Manchester have recently been announced: reader in mathematics, M. J. Lighthill; reader in pharmaceutical chemistry, Dr. K. Bullock; senior lecturer in mathematics, G. N. Ward; lecturer in physics, J. A. Newth; lecturer in chemistry, M. C. Whiting.

NEW officers of the British Non-Ferrous Metals Research Association have been elected as follows: the Hon. R. M. Preston, chairman of Council, in succession to Sir John Greenly; Mr. F. C. Braby, vice-chairman and honorary treasurer; and Dr. Maurice Cook, chairman of the Research Board.

APPLICATIONS are invited for Lady Tata Memorial Fund grants and scholarships to scientific workers of any nationality for research in diseases of the blood, with special reference to leukæmia, in the year beginning October 1, 1950. Grants are made for research expenses, and scholarships are awarded as personal remuneration, their normal value being £400 per annum. Applications must be submitted before March 31, and the awards will be announced in June. Further particulars and forms of application may be obtained from the Secretary of the Scientific Advisory Committee, Lady Tata Memorial Fund, c/o Medical Research Council, 38 Old Queen Street, Westminster, London, S.W.1.

CHEMISTRY OF FLUORINE

On November 30 a symposium on fluorine chemistry was held by the Chemical Society at the Royal Institution, London. The choice of this subject is indicative of a rapid growth of interest in both inorganic and organic fluorine compounds. Twenty years ago, elementary fluorine was available in few laboratories and little work on its compounds was in progress. During the war years, however, progress was rapid, particularly in various laboratories in the United States, and the fields opened up then are being more fully explored now. The topics dealt with at the symposium, representing some of the research in progress in Great Britain, were diverse, and for this reason each is separately reviewed below.

Anode phenomena in the production of fluorine (A. J. Rudge). Hitherto, relatively little has been published on the anode phenomena occurring in the medium-temperature fluorine cell, which is the type now commonly used for the laboratory and technical production of the element. It has been found that when potassium fluoride–hydrogen fluoride mixtures containing at least 42 per cent of hydrogen fluoride are electrolysed with a carbon anode, the contact angle between anode and melt is 150–160°. Provided a critical current-density is not exceeded, no bubbles of fluorine leave the anode surface. Instead, gas evolution occurs at the electrode/electrolyte/gas space interface. This, and the limited spread of the evolved hydrogen, has the important consequence that no diaphragm need be used in a carbon-anode fluorine cell. Anodic polarization, hitherto a common source of trouble during the generation of fluorine, is influenced by various factors such as the current density, electrolyte composition and its water content and the anode material. With suitable grades of amorphous carbon of high permeability, however, polarization difficulties may be eliminated up to current densities of 1 amp. per square inch, this satisfactory performance being maintained over the whole useful range of electrolyte composition and operating temperature.

Preparation and properties of chlorine trifluoride (R. le G. Burnett and A. A. Banks). Chlorine trifluoride, first prepared on a laboratory scale in 1930 by Ruff and Krug, can now be made and handled on a technical scale. The density, surface tension and parachor have been measured and their implications discussed. Several publications on the controlled reactions of chlorine trifluoride have already appeared in the literature, but it was not realized hitherto that fluorocarbons or even carbon tetrachloride could be used as reaction media. In these media hydrogen in organic compounds is substituted in roughly equal proportions by chlorine and fluorine. Complete replacement of hydrogen is, however, difficult; to take an example, with hydrocarbons containing eight or more carbon atoms in the molecule, about 15 per cent of the hydrogen remains, even with a final reaction temperature of 150°.

Bromine trifluoride as an ionizing solvent (H. J. Emeléus, A. G. Sharpe, A. A. Woolf and V. Gutmann). Pure bromine trifluoride at 25° has a specific conductivity of 8×10^{-3} ohm^{-1} cm.$^{-1}$, the corresponding values for chlorine trifluoride (at 0°) and iodine pentafluoride (at 25°) being $< 10^{-6}$ and $2-3 \times 10^{-5}$ ohm^{-1} cm.$^{-1}$ respectively. Bromine trifluoride is believed to ionize to a small extent according to the equation $2BrF_3 \rightleftharpoons BrF_2^+ + BrF_4^-$. Adopting the broad definition of acids and bases as compounds which, in a particular solvent, give rise respectively to the cation and anion of the solvent, acids and bases in bromine trifluoride should yield the above ions. The bases $KBrF_4$, $AgBrF_4$ and $Ba(BrF_4)_2$ have, in fact, been prepared by dissolving the corresponding fluorides or other salts of these metals in bromine trifluoride and evaporating excess of the solvent. Similarly, several acids have been isolated (BrF_2SbF_6, $(BrF_2)_2SnF_6$, BrF_2AuF_4, BrF_2NbF_6, BrF_2TaF_6). It is also possible to carry out a conductimetric titration of an acid with a base in this solvent (for example, $AgBrF_4 + BrF_2SbF_6 = AgSbF_6 + 2BrF_3$). The gold acid BrF_2AuF_4 is of special interest because, when heated, it yields the hitherto unknown auric fluoride, AuF_3.

Certain bases (for example, $Ca(BrF_4)_2$) are known to be unstable and to lose bromine trifluoride readily. Similarly, there are probably various unstable acids, the intermediate existence of which can be inferred only from the products of reactions. Potassium metaphosphate, for example, when treated with bromine trifluoride, forms potassium hexafluorophosphate, which is believed to result from a neutralization reaction between the base $KBrF_4$ and the acid BrF_2PF_6. Hexafluoroarsenates are formed rather similarly, and by dissolving silver and bismuth pentafluoride in bromine trifluoride it is possible to prepare silver hexafluorobismuthate. The same principle, involving reactions of the unstable base NO_2BrF_4 (formed from NO_2 and BrF_3), may be used to explain the formation of a number of new derivatives of the NO_2 ion (NO_2BF_4, $(NO_2)_2SnF_6$, NO_2PF_6, NO_2AsF_6, NO_2SbF_6, NO_2AuF_4).

Dissociation energy of the fluorine molecule (M. G. Evans, E. Warhurst and E. Whittle). From a review of available data, it appears that a value of $D(F_2)$ of 33–43 kcal. mol.$^{-1}$, based on recent work by Schmitz and Schumacher and by Wahrhaftig, is more probable than the hitherto accepted value of 63·5 kcal. mol.$^{-1}$ obtained by von Wartenberg. With a value of the dissociation energy in the lower range, the value of the electron affinity of gaseous fluorine must be less than that of chlorine. The electron affinity of fluorine in solution remains, however, larger than that of chlorine, and the conclusions regarding the ionic character of covalent bonds involving fluorine remain unchanged.

During the discussion of this paper, R. F. Barrow presented evidence obtained by a spectroscopic study of cæsium, rubidium and thallous fluorides, which leads to a value of $D(F_2)$ of 45–50 kcal. mol.$^{-1}$, that is again considerably lower than the present standard value.

Rates of reaction of sodium atoms with fluoromethanes (M. G. Evans, E. Warhurst and E. Whittle). The Polanyi sodium-flame technique applied to the series CH_3F, CH_2F_2, CHF_3 and CF_4 leads to some interesting results. A maximum velocity constant is observed for CHF_3, whereas in the corresponding chloro- and bromo-methane series there is a progressive increase from the mono- to the tetra-halide. The two opposing factors influencing the activation energy of these reactions were considered. The first, an increase in resonance energy of the Polanyi–Evans transition state in the series CH_3F to CF_4, causes a steady increase in the rate. This, however, is opposed by a progressive increase in the C—F bond energy, for which some experimental evidence is now available.

Organic fluorine compounds (M. Stacey). In a general survey of the present position of organic fluorine chemistry, the methods available for the introduction of fluorine into organic compounds were first surveyed. These include the use of reagents such as hydrogen fluoride, antimony trifluoride and other metallic fluorides for the replacement of chlorine, bromine or iodine by fluorine in halohydrocarbons, and the use of fluorides which require elemental fluorine for their preparation. The method of fluorination involving fluorine itself in the presence of a gold- or silver-plated copper catalyst was then considered, and the advantages of the reactive metallic fluorides, such as argentic fluoride or cobalt trifluoride, as agents for the vapour-phase fluorination of organic compounds, were mentioned. It appears probable that this method can be applied under certain conditions to produce fully fluorinated heterocyclic compounds.

A novel polymerization reaction involves the polymerization and simultaneous fluorination of fluorohydrocarbons by fluorine and leads to the formation of stable fluoro-oils. A further interesting development relates to the synthesis of perfluoro adipic acid by the oxidation with potassium permanganate of unsaturated products obtained by the low-temperature fluorination of benzene.

Chemistry of iodotrifluoromethane and iodopentafluoroethane (R. N. Haszeldine and Miss J. Banus). The C—I bond in iodotrifluoromethane breaks heterolytically under certain conditions to give reactions involving a 'positive' iodine atom. Thus with potassium hydroxide, fluoroform and not trifluoromethyl alcohol, together with potassium hypoiodite, is obtained. This reaction has been studied radiochemically in alcohol solution. The homolytic fission of the C—I bond in the fluoroiodides yields fluorocarbon radicals such as CF_3, and these radicals initiate the chain polymerization of olefines. With ethylene, polymers of the type $CF_3[CH_2CH_2]_nI$ ($n = 1$–4) have been synthesized; and from these, trifluorohydrocarbons of the general formula $CF_3(CH_2)_nCH_3$ are obtained; polymers of the type $CF_3[CF_2CF_2]_nI$ ($n = 1$–15) are likewise formed with tetrafluoroethylene. The fluoroiodides obtained from tetrafluoroethylene have also been converted into oils and greases comparable with fluorocarbons in their stability; furthermore, these long-chain fluoroiodides act as sources of long-chain fluorocarbon radicals.

The formation of organometallic compounds from CF_3I and C_2F_5I has been achieved, and the compounds CF_3HgI (and derivatives), $Hg(CF_3)_2$, $As(CF_3)_3$, $As(CF_3)_2I$, $S(CF_3)_2$, $P(CF_3)_3$ and $P(CF_3)_2I$ were described. The properties and reactions of certain of these compounds were considered, and it was evident that they are useful intermediates for the synthesis of other compounds containing fluorocarbon groups. A further interesting reaction involving fluorocarbon radicals led to the synthesis of trifluoropropyne, a compound of great potential synthetic value.

Trifluoroacetic acid and its derivatives (J. C. Tatlow). The methods currently available for the synthesis of trifluoroacetic acid, and some of its reactions, were described. The anhydride of this acid has interesting properties. Hydroxyl groups may be trifluoroacetylated, and the unusual properties of sugar trifluoroacetates were revealed. They are unstable compared with normal acetates and are readily hydrolysed by moisture; ethyl alcohol causes alcoholysis to the parent sugar. Since the trifluoroacetyl group is not removed during subsequent tosylation or acetylation reactions in pyridine solution, however, the trifluoroacetyl group may prove to be of use as a 'blocking' group in carbohydrate chemistry.

A mixture of acetic acid and trifluoroacetic anhydride gives sugar and alcohol acetates in good yield; even cellulose may be acetylated successfully by this method. It is of interest to note that amines form the trifluoroacetyl derivative, and not the acetyl derivative, when treated with a carboxylic acid and trifluoroacetic anhydride.

With nitric acid, trifluoroacetic anhydride forms an active nitrating mixture, and excellent yields of the nitro derivatives of nitrobenzene, benzonitrile and bromobenzene may be obtained; it appears likely that even aliphatic nitration may occur under mild conditions. The value of trifluoroacetic acid in synthetic organic fluorine chemistry is apparent.

H. J. EMELÉUS

HORMONE ASSAYS

A SYMPOSIUM on "Hormone Assays" was held on October 20 in London, organised jointly by the Biological Methods Group of the Society of Public Analysts and Other Analytical Chemists and by the Society for Endocrinology. Seven papers were read, dealing with the assay of insulin, posterior pituitary, gonadotrophins, thyroid, œstrogens (in man), and with general principles of bioassay. The Biological Methods Group is to be congratulated on its enterprise. Previous symposia organised by the Group have dealt with penicillin assay, the assay of curare and curaremimetic substances, the evaluation of selective weed-killers and other bioassay problems of general interest. These discussions are, as a rule, published in full in the *Analyst.* A shortened abstract of the present meeting will also be published in the *Journal of Endocrinology.*

Although certain hormones may be detected by colorimetric or other chemical reactions, in most cases these are not sensitive enough, and bioassay methods are required. Hormone assays are often conducted without proper regard for the principles of biological assay, and much of the discussion at the meeting was devoted to reconsidering these principles as they apply to hormone assays. In general, bioassays are of two kinds: those in which standard and unknown differ quantitatively, and those in which they differ qualitatively. Assays of the first kind have the same object as chemical determinations, and they are used only where no adequate chemical methods are available. The design of these assays has been greatly improved during the past few years, and they can now be rendered extremely accurate. Particularly satisfactory are those assays in which, as in the standardization of insulin, standard and unknown can be relied upon to be pure and have the same chemical composition. Assays of mixed and impure extracts, such as the assay of sex hormones or gonadotrophins in urine, are rather less satisfactory. In these cases more than one active principle is usually present, and there is the danger that the unknown solution may be assayed in terms of a standard of different composition. Prof. J. H. Gaddum discussed some of the difficulties arising in the interpretation of these assays.

Experiments in which the biological actions of different chemical substances are compared are not always classified as bioassays, but there is no reason why they should be excluded. In practice, they are of the greatest importance, since all preparative pharmacology—the preparation and the determination of activity of new substances—is based on this type of assay. Dr. P. M. F. Bishop's paper showed that such assays can be performed in man and can give consistent results. It must be realized, however, that when different chemical substances are compared, the result of the assay depends on the method, end-point and species used, and any comparative figure is valid only for particular circumstances.

Prof. J. H. Gaddum (University of Edinburgh), the chairman, said that the reason why certain substances are assayed by biological methods is that some drugs, such as insulin, cannot be controlled in any other way, and some drugs, such as acetylcholine, are commonly present in concentrations which are too low to be detected in any other way. Analysts are interested in accuracy and endocrinologists in discovering new facts. The object of the meeting was that endocrinologists should learn accuracy and that analysts should learn something of the difficulties of the endocrinologists. Bioassays should be based on the following principles: each assay should consist of a comparison between an unknown preparation and a standard one; each of these preparations should contain the same single active principle and no other substance which modifies its action in the test; each assay should be complete in itself and should involve no arbitrary assumptions about such things as the slope or even the shape of the dose-effect curve, and the limits of the error should be calculated from the internal evidence of each assay.

It is quite impossible to attach any real meaning to the results of assays of unknown mixtures of œstrogens. Estimates which purport to give 'œstrogenic activity' of such mixtures are liable to vary over a thirty-fold range or more, according to the way the test is done. The only possible way of getting results with any intelligible meaning in bioassays of mixtures of œstrogens seems to depend on removing the interfering substances and separating the œstrogens from one another before the biological tests are made. There can be no justification for speaking, as some still do, of 'mouse units' of chorionic gonadotrophin. An international standard preparation of this substance is available, and results should be given in international units. Apart from the provision of reliable preparations of hormones, the contribution which bioassays can make to clinical endocrinology depends on the estimation of hormones in blood and urine. The concentration in the urine may provide an indirect estimate of the daily output of hormone. If, for example, it is found that when a hormone is injected 5 per cent of it appears in the urine, it may be justifiable to make the provisional assumption that the daily output by the gland is equal to the amount excreted in the urine multiplied by twenty. The time will probably come when provision for assays of this kind will be an essential part of the equipment of all large hospitals. The discovery of more sensitive methods is an important objective; at present only chorionic gonadotrophin is present in sufficient concentration to be accurately estimated in both blood and urine.

Dr. H. O. Schild (University College, London) said that digitalis and posterior pituitary are examples of mixed extracts of undefined composition, in which standardization in animals might be misleading. Should these extracts be standardized in man? Even if the technical difficulties could be completely overcome, there would remain the objection that activity ratios as found in one man and one disease might not apply to others. The problem of standardizing accurately, for human use, mixed extracts containing several related pharmacological principles is essentially insoluble; but animal standardizations may be regarded as a useful safeguard against worthless preparations.

Statistics have immensely improved the planning and interpretation of biological assays. The old non-statistical methods have, however, not been completely superseded. For example, the old 'bracketing' method, by which standard and unknown are matched by trial and error, is still widely used in research work. This has some justification, since the method involves no assumptions of a mathematical relation between dose and effect. On the other hand, most statistical methods involve some such assumption and for that very reason are subject to certain fallacies.

The measurement of thyroidal activity was discussed by Dr. G. F. Somers (Glaxo Laboratories, Greenford). At present the official British Pharmacopœia method of standardization is based on an estimation of acid-insoluble organically combined (thyroxine) iodine. The United States Pharmacopeia makes use of the total iodine content present in thyroid combination. The British Pharmacopœia method is probably satisfactory for thyroid preparations, but is unsatisfactory for the assay of artificially iodinated proteins and for evaluating the thyroidal activity of thyroxine analogues. For this purpose, biological methods must be used. These are commonly based on the following reactions: (1) changes in respiratory metabolism; (2) decreased susceptibility to anoxia; (3) loss in body-weight; (4) decrease in susceptibility to toxic substances; (5) premature metamorphic changes in amphibians; (6) restoration and maintenance of growth in thyroidectomized rats; (7) antagonism to goitrogenic drugs. Using the first method, the following relative activities of thyroxine derivatives were obtained: *dl*-thyroxine sodium (standard), 1·0; thyroxine methyl ester, 0·65; thyroxine ethyl ester, 0·51; N-formyl thyroxine, 0·33; *l*-thyroxine sodium, 1·95. These figures cannot give a true index of the activity for man, which can only be settled by clinical trial. Dr. Rosalind Pitt Rivers said there is evidence that *d*-thyroxine is active when tested on myxœdema patients; it has 1/8 to 1/10 the activity of *l*-thyroxine.

Dr. J. A. Loraine (University of Edinburgh) said that the anterior lobe of the pituitary produces at least three gonadotrophic hormones. These are the follicle-stimulating hormone, the luteinizing hormone and luteotrophin. In addition, there are two important gonadotrophins: chorionic gonadotrophin elaborated by the human placenta with predominantly luteinizing action, and pregnant mares serum gonadotrophin, which is predominantly follicle-stimulating. Animal tests for the assay of chorionic gonadotrophin may be divided into primary and secondary, according to whether the organs inspected are the gonads themselves or organs affected secondarily by the liberation of œstrogens or androgens from the gonads. The primary tests register effects on corpora lutea, ovarian weight, ovarian hyperæmia in rats, rabbit ovulation and xenopus; the secondary tests on uterine weight, vaginal smears, vaginal smears in B-deficient rats, seminal vesicles and prostatic weight. Dr. Loraine has found the assay depending on prostatic weight to be convenient and sensitive. An advantage of this test is that the œstrogens normally present in pregnancy urine do not interfere with the assay. By this method 20,000–40,000 I.U. of chorionic gonadotrophin appeared to be excreted in twenty-four hours from the fortieth to eightieth day of pregnancy and less than 10,000 I.U. after the third month. The estimation of gonadotrophins in the urine of men, non-pregnant women and children is at present unsatisfactory. Dr. Annie M. Hain (Manchester) and Dr. G. I. M. Swyer (London) discussed the production of gonadotrophins in testicular tumours. These may be derived from two sources, the patient's anterior pituitary and the tumour.

In discussing the assay of insulin, Mr. K. L. Smith (Boots, Ltd., Nottingham) said that this is done either by a fall in blood sugar in rabbits or by the incidence of convulsions in mice. The accuracy of the mouse method is such that the use of some eight hundred mice should give an estimate accurate to ± 10 per cent at $P = 0 \cdot 95$. It would require 240 rabbit responses to obtain the same accuracy by the blood-sugar method.

The assay of posterior pituitary lobe extracts was considered by Mr. G. A. Stewart (Wellcome Laboratories, Dartford). The oxytocic principle is usually assayed by the guinea-pig test *in vitro* ; but this assay may be misleading since the guinea-pig uterus reacts also to vasopressin. Moreover, the sensitivity to vasopressin varies according to the hormonal state of the uterus and the magnesium concentration of the solution. Oxytocin may be satisfactorily assayed by the fall of blood pressure produced in chickens ; this test is not normally affected by vasopressin.

Miss M. H. I. Macauley mentioned the anæsthetized rat method for assaying vasopressin, which is found to be sensitive, specific and discriminating.

The clinical methods of assaying œstrogens were discussed by Dr. P. M. F. Bishop (Chelsea Hospital, London). When the stilbene group of synthetic œstrogens was introduced by Dodds and his co-workers, their relative potency was tested on the vaginal smear changes of castrated rats and mice. Hexœstrol and dienœstrol were found by these tests to be more potent than stilbœstrol. Clinical experience soon gave rise to the impression that these ratios of potency might not hold good in the human subject. In trying to compare these drugs in man, the following end-points were submitted to scrutiny : (1) the hot flush count in menopausal women ; (2) the vaginal smear in menopausal women ; (3) the induction of œstrogen-withdrawal bleeding. Only the third proved a practicable assay method. The general plan was that 2 mgm. stilbœstrol were administered daily by mouth for a fortnight to chosen cases of amenorrhœa. Depending on whether œstrogen-withdrawal bleeding took place or failed to do so, the dose was lowered to 1 mgm. or increased to 3 mgm. daily for fourteen days. The mean of the two doses which just failed and just succeeded was taken as the therapeutic unit. In the same patient a therapeutic unit for another œstrogen was then established.

A thousand courses of œstrogen have been administered, and the results are remarkably consistent. Dienœstrol was found to be about a quarter, and hexœstrol about an eighteenth, as potent as stilbœstrol. It should be emphasized that these ratios of œstrogenic potency only apply to women in the age-group of maturity, suffering from amenorrhœa. There is no guarantee that the same ratios would hold, for example, for the response to œstrogens of women of menopausal age or of men with prostatic carcinoma.

Dr. W. A. Broom (Nottingham) said that the results of his assays in rats on stilbœstrol, hexœstrol and dienœstrol agree well with Dr. Bishop's clinical results. However, with ethinyl œstradiol the agreement ceases, since in rats this substance is five times less active than stilbœstrol, while clinically it is 100–200 times more active.

H. O. Schild

IRRADIATION OF MIXED TISSUES

By Dr. W. H. LOVE

Department of Physics, University of Sydney

An examination of the various researches that have been made into the quantitative effects of radiations on cells and tissues shows that the relationship between q, the radiation dose, and P, the proportion of cells of a given type T_1 that survive the dose q, is represented by a sigmoid curve A_1 (Fig. 1).

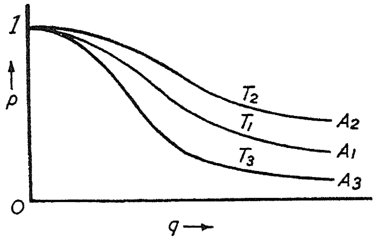

Fig. 1

If cells of type T_2 are less 'radio-sensitive' than those of type T_1, and if cells of type T_3 are more sensitive than those of type T_1, then it seems to have been generally assumed that the survival curve A_2 for type T_2 will be everywhere above A_1 and that the survival curve A_3 for type T_3 will be everywhere below A_1.

The object of the present communication is two-fold: (i) to show that the curves may cross, and (ii) to pursue some of the immediate consequences of (i).

If a tissue of given type is acted upon by radiation of a given quality, it is known that the fractional survival P, associated with a dose q, is determined by $fn(\lambda q)$, the first $n + 1$ terms of the Poisson series in λq, where n and λ are characteristic of the tissue and the quality of the radiation.

Let A_1 (Fig. 2) be the survival curve for tissue T_1 characterized by n_1 and λ_1, and let A_2 be the survival curve for tissue T_2 characterized by n_2 and λ_2. Then if $n_2 > n_1$ and $\lambda_2 < \lambda_1$ the curve A_2 will be everywhere above A_1 and the survivals will be determined by :

$$P_1 = fn_1(\lambda_1 q),\ P_2 = fn_2(\lambda_2 q).$$

Consider now a third tissue T_3 the cells of which are characterized by n_2 and λ_3, and suppose that λ_3/λ_2 is some proper fraction equal, for example, to the ratio q_2/q_1. Then its survival curve A_3 will be determined by :

$$P_3 = fn_2\left(\lambda_2 \frac{q_2}{q_1} q\right),$$

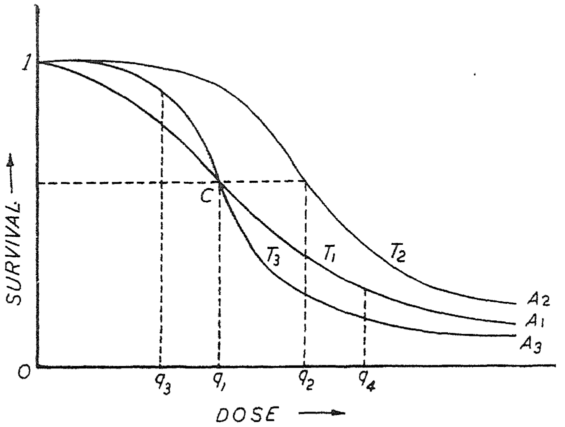

Fig. 2

and it may be obtained from that of T_2 by reducing all the abscissæ of T_2 in the ratio q_1/q_2.

In this particular case the point C will be common to each of the curves A_1 and A_3, and it can be shown both analytically and graphically that the curves cross at this point.

Adoption of a more general approach to the problem leads to the conclusion that the survival curve for one tissue T_A, characterized by n_A, λ_A, will cross that for another tissue T_B, characterized by n_B, λ_B, provided that: (i) $n_A > n_B$ and $\lambda_A > \lambda_B$, or (ii) $n_A < n_B$ and $\lambda_B > \lambda_A$, the point of crossing being determined by the particular values of the characteristic quantities.

It is now a matter of interest to examine some of the consequences of this result.

Consider the conclusions that may be drawn by three observers each of whom set out independently to measure the relative sensitivities of the tissues T_1 and T_3 by comparing the relative survivals P_1 and P_3 associated with some particular dose q. If the first observer operated in the region $0 < q < q_1$, he would conclude that tissue T_1 was more sensitive than T_3; if the second observer operated in the region $q > q_1$, he would arrive at the opposite conclusion; and if the third observer chose to administer a dose in the immediate vicinity of q_1, he would find that the tissues were equally sensitive. Each would be correct within the limits imposed by the conditions of his experiment, and it becomes apparent that conclusions based on isolated observations of this kind could be misleading to the observers both individually and collectively.

Suppose now that each of the first two experiments were performed by the one observer who administered a dose $q < q_1$ to one sample of the tissues T_1 and T_3, and then a dose $q > q_1$ to another sample of the same tissues. He would become aware of an apparent 'reversal' of the sensitivities. If he had used the one sample of tissues in both experiments, so that the first irradiation of the sample was afterwards followed by a second irradiation of the same sample, he might assume that his results justified the conclusion that the resistance of the tissue T_1 had been enhanced by the initial treatment.

The fractionation technique in which a given total dose is administered in a number of fractional doses assumes a particular significance when we consider its bearing on the question of survival in tissues the survival curves of which are related like those for T_1 and T_3. Let us assume that our aim is the achievement of an end result in which the minimum survival in T_1 is accompanied by a maximum differential effect between T_1 and T_3, subject to the condition that the survival in T_3 is greater than that in T_1.

Reference to Fig. 2 shows that the appropriate fractional dose in the circumstances is one in the vicinity of q_3. The differential effect associated with the dose q_1 is zero; that associated with a dose in the neighbourhood of q_4 may be substantial but the prescribed condition is not satisfied.

In the radiotherapeutic treatment of malignant conditions a beam of radiation is directed on to a composite structure in which malignant cells of one type are embedded in a tissue composed of cells of another type, and the possible crossing of the associated survival curves assumes a distinct practical significance.

POSITIVE IONS IN GAS DISCHARGES

By R. L. F. BOYD
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THE treatment of the ions in the positive column of a glow discharge as though they had a Maxwellian velocity distribution, giving a current density to a strongly negative probe equal to the random ion current-density in the plasma, is frequently inconsistent with 'Langmuir' probe measurements, which on this theory would lead to the untenable conclusion that the positive ions had a temperature equal to or greater than that of the electrons[1]. In order to elucidate this anomaly and to obtain experimental data on the positive ion energies, experiments have been carried out on the positive column of a 7-cm. diameter hot-cathode glow discharge in argon, using a plane Langmuir probe screened with a very fine wire grid (14 strands of 0·016 mm. tungsten across a 1-mm. diameter hole). The grid was made using the hydrogen atmosphere brazing technique employed in the manufacture of planar triodes. The probe construction is shown in Fig. 1.

By using this electrode system as a Langmuir probe and making the collector behind the grid alternately strongly positive and strongly negative, it has been possible to separate the Langmuir probe characteristic into its negative and positive components, secondary emission from the collector by neutral particles being shown as a saturation minimum to the positive ion component. One such curve is shown in Fig. 2. Previous attempts[2,3] have been made to use grids or perforated electrodes to split the characteristic into its two components; but the electrode assemblies being large, it was necessary

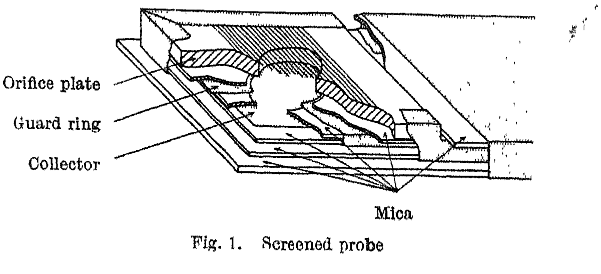

Fig. 1. Screened probe

always to maintain the grid at a potential negative to the space in order to prevent it from becoming the anode. The analysis of the positive ion energies was carried out using retardation by the collector after the initial acceleration of the ions by the field in front of the grid. Unfortunately, however, this method does not give a result characteristic of the discharge, for reasons which will now be given.

A consideration of the mechanism of sheath formation in electropositive gases has led to the conclusion that, for a localized positive ion sheath to form on a plane negative electrode, the distribution function $f(E)$ of the energies associated with the components of the positive ion velocities normal to the sheath edge must comply with the condition

$$\frac{2\int_0^\infty f(E).\,E^{1/2}.\,dE}{\int_0^\infty f(E).\,E^{-1/2}.\,dE} > V_e.$$

($V_e = kT/e$, where T is the electron temperature and k is Boltzmann's constant.) Unless this condition is satisfied the positive ion current will not become saturated, and the field from the probe will penetrate into the plasma. The penetration of this field modifies the energy distribution and the concentration of the positive ions in the probe neighbourhood until, if the probe voltage is sufficient, the condition is satisfied and the sheath forms.

By using a very small electrode assembly, it has been possible to measure the energy distribution of the ions by varying the grid potential, so that the distribution is undisturbed by a penetrating field.

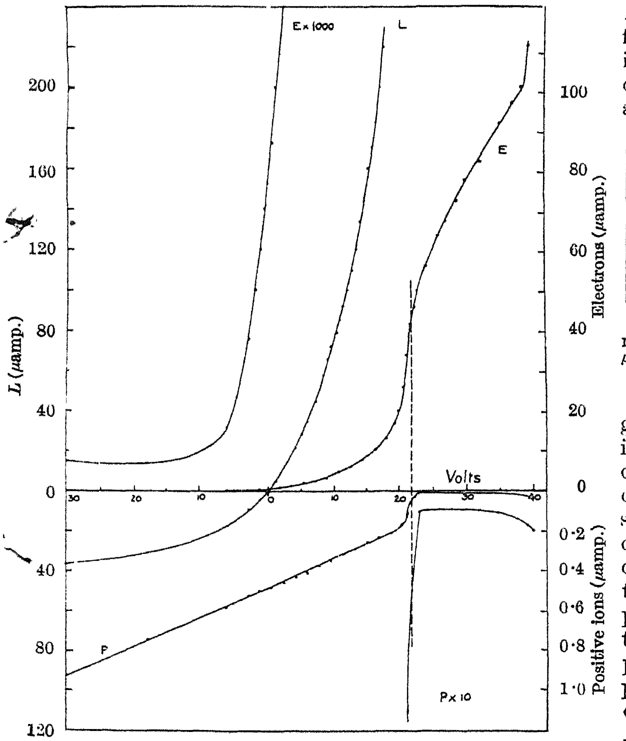

Fig. 2. Screened probe characteristic in argon at 0·0009 mm. Hg, at 100 m.amp. tube current. L, Langmuir curve; E, electron component; P, positive ion component

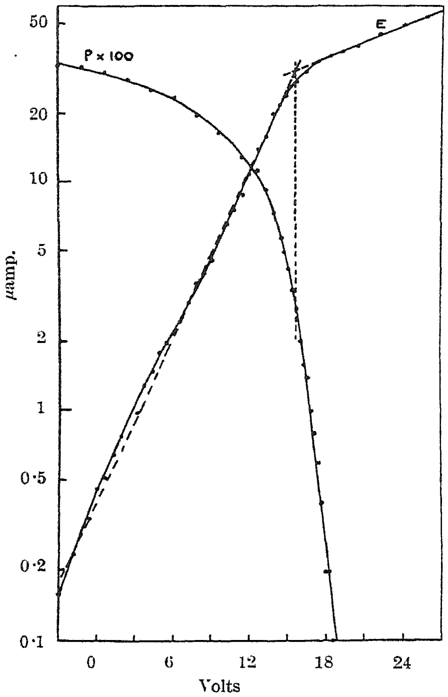

Fig. 3 Semi-logarithmic plots of electron and positive ion current to the screened probe, in argon at 0·004 mm. Hg, at 100 m.amp. tube current

By making the reasonable assumption that the predominant collision process in the mobility mechanism for the ions is charge exchange (so that each ion starts almost from rest after making a collision[4]), expressions have been obtained for the probe voltage ΔV necessary to cause positive ion saturation, and for the ratio of the saturation probe current for idealized high-pressure and low-pressure cases (order of 1 mm. and 10^{-3} mm. mercury respectively). They are given in the accompanying table.

	High pressure	Low pressure
ΔV	$\frac{V_e}{2}\log\left\{\frac{V_e}{\beta}\cdot\left(\frac{\mu}{v+}\right)^2\right\}$	$0{\cdot}7\ V_e$
$(i_e/i+)$	$\frac{1{\cdot}62\times10^7}{v+}\ V_e^{1/2}$	$1{\cdot}04\ \left(\frac{M+}{M_e}\right)^{1/2}$

β = Mean free path (charge exchange) × pressure (cm. × mm. mercury). $v+$ = mean normal component of positive ion velocities. μ = Sena's mobility constant. (Practical units are used.)

Reference to Fig. 3, which gives the semilogarithmic graph of the positive ion and electron-probe currents in an argon discharge at 0·004 mm. mercury, shows clearly that the positive ion saturation does not occur until the probe is about 3 volts negative to the space potential. The calculated value of ΔV for this case is 2·7 volts. Curves taken for various probe orientations show that the positive ion velocity-distribution is very anisotropic, and also that at pressures both above and below 0·004 mm. mercury the mean positive ion energy is less than at this pressure. At the pressure for the curves shown, the positive ion 'temperature' determined from the slope of the curve is about 0·3 of the electron temperature. At a pressure of 0·75 mm. mercury it was approximately gas kinetic, while at 0·0009 mm. mercury it was about 0·1 of the electron temperature.

The screened probe has been found to be of special value in studying the electron-energy distribution at the high-energy end. In argon the distribution has been found to fall well below the Maxwellian value at energies above 15 volts. These facts are of considerable importance in the study of the reaction-rates of processes occurring in the plasma, and the study is now being extended to include electro-negative gases. A fuller account of these experiments will shortly be published elsewhere.

[1] Langmuir and Tonks, *Phys. Rev.*, 34, 876 (1929).

[2] Tonks, Mott-Smith and Langmuir, *Phys. Rev.*, 28, 104 (1926).

[3] Sena, L., *Trans. All-Union Electrotechn. Assoc.*, 42 (1935).

[4] Sena, L., *J. Phys. U.S.S.R.*, 10, 179 (1936).

SCATTERING OF WAVES BY SPHERICAL PARTICLES

EVER since Tyndall's beautiful series of experiments in 1868 demonstrating the relationship between the intensity and polarization of light scattered by suspended particles and the density of the particles, and Rayleigh's subsequent deduction, on the elastic solid concept of æther vibration, that for particles of size very much smaller than the wave-length of light the intensity of scattering is proportional to the inverse fourth power of the wave-length, much interest, both theoretical and experimental, has been taken in this phenomenon of scattering. In 1908, the first rigorous treatment, according to the methods of electromagnetic theory, of the complete diffraction of a plane wave by a spherical particle of any composition was given by Gustav Mie, and this has become the classic contribution to the subject upon which subsequent discussions have been based.

Several years ago the Computation Laboratory of the United States National Bureau of Standards applied the Mie theory to compute extensive tables of scattering functions for both real and complex values of the index of refraction of spherical particles, and these have recently been published*.

The various intensity functions, which are listed, give the angular distribution of intensity and the total light scattered as a function of $\alpha = 2\pi r/\lambda$, where r is the radius of the small spherical particle from which the light is scattered; r is approximately equal to λ, the wave-length of the incident light. From the angular distribution and the total light scattered by a suspension of particles of uniform size, the particle-size and concentration can be deduced, and the method of deduction is described. The tables are divided into four sections, the first three of which relate to real indices of refraction m, and the fourth to certain complex indices. In Part 1 the angular distribution functions, proportional to the intensities of the two incoherent, plane-polarized components scattered by a transparent particle illuminated with natural light, for values of m between $1{\cdot}33$ and $2{\cdot}00$, and in Part 2 the total scattering coefficient, for $m = 1{\cdot}50$, are tabled. From Part 3 the total scattering (and absorbing) coefficient can be obtained for absorbing materials of extinction coefficient varying between 0 and $0{\cdot}1$ and of m between $1{\cdot}44$ and $1{\cdot}55$. The sets of tables for real m were computed originally on the recommendation of Prof. V. K. La Mer, professor of chemistry at Columbia University, and arose out of a series of investigations relating to chemical warfare. In Part 4 the tables have been extended to certain values of complex arguments and have application in microwave radar, where the echoes received on radar sets from suspended or falling water-droplets in the atmosphere are a particular case of the scattering problem. The range of wave-length thus considered is 10 cm.–3 mm., and the dispersion measurements made by Dr. J. A. Saxton, of the National Physical Laboratory, are used.

An admirable foreword to the tables is contributed by Prof. J. A. Stratton, who briefly reviews the history of the problem of scattering, describes Mie's formal solution, the method by which the tables have been compiled, and their particular applications. Confidence is expressed that the tables will be of considerable benefit to physical and biological science. Mathematical definitions of the tabulated functions, as well as the physical significance of the tabulated quantities, together with a short bibliography, are given in the introduction. The tables themselves are clear and easy to read, though the size and spacing of the numbers in the tables vary almost from page to page. The paper cover is to be deplored.

S. WEINTROUB

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* U.S. Department of Commerce: National Bureau of Standards. Applied Mathematical Series 4: Tables of Scattering Functions for Spherical Particles. Pp. 119. (Washington, D.C.: Government Printing Office, 1948.) 45 cents.

REPEATABILITY OF TEST RESULTS

A RECENT meeting of the London Group of the Royal Statistical Society's Industrial Applications Section was devoted to a discussion of the difficulties arising from discrepancies in what are supposed to be replicate test results.

Especially in the field of chemical analysis, a great deal of empirical standardization has taken place, resulting in the publication of handbooks of standard methods of tests. These, by closely specifying the conditions of test and even in some cases the dimensions of the apparatus used, endeavour to reduce the variation experienced. It is well known, however, that in spite of these attempts at reducing variation, differences between the results of tests on the same sample made by different laboratories are experienced which are larger than those found between replicate results of the same observer or even by different observers in the same laboratory using the same apparatus.

Following the lead of the Institute of Petroleum in its Standard Methods Handbook, the names 'repeatability' and 'reproducibility' are given to measures of the two kinds of variability, between replicates of the same operator and between laboratories. Mr. A. H. Dodd, of Newton, Chambers and Co., criticized this choice of names on the grounds of confusion, since in ordinary use the two words mean much the same. If there is any difference, it is that reproducibility implies an attempt to make two results alike, thus introducing the suggestion of faking results. He thought that the coining of new words (and he gave as an example the word 'squariate' for squared deviation) preferable, in this instance at least, to the twisting of old ones to bear new meanings. The new words would be even more acceptable if they conveyed within themselves the ideas of these two separate sources of variation.

Mr. J. R. Fraser, Government Chemist's Laboratory, discussed an analysis by the late Dr. Tocher of 356 test results, obtained from ten different laboratories and involving thirty-five different operators, on portions of the same material. A previously held suspicion that results from different laboratories would be significantly different was confirmed. The report makes no attempt to distinguish the two kinds of variability, but directs the attention of analysts to the need to avoid local techniques. It is, in other words, a plea for the standardization which is now being brought about. Mr. Fraser made the point that, while it is necessary to recognize and to measure the two kinds of variation, a method of test cannot be regarded as good until the two are equal; that is, the replication of a test in another laboratory should be subject to the same variability as one by the same operator. He also stressed the fact that good replication cannot be taken to indicate the correctness of the result.

After reviewing former procedure, Mr. G. Claxton, of the National Benzol Co., pointed out how the work of the Standardization of Tar Products Tests Committee and similar bodies has considerably reduced the disagreement which formerly existed between laboratories. The discrepancies have been reduced, but not completely to the level of the repeatability that a single operator can achieve. It is necessary to have some measure of each of the sources of variability in order, first, that an operator may know that his technique and apparatus are reasonably good, since departure in either respect presumably leads to greater variability among his own replicates; and, second, in order that due weight may be given to discrepancies between the test results of different laboratories.

When, in drawing up specifications, an attempt is made to allow for discrepancies between laboratories, difficulties arise. Mr. Claxton illustrated this by reference to one particular test, that for the sulphur-content of motor benzol, usually specified to be not more than 0·4 per cent by weight. The usual procedure is that the maker, having collected a bulk for dispatch, draws a sample, of which one portion is sent to a central laboratory and the other tested in his own laboratory. These two portions will be almost identical in sulphur-content, even though owing to difficulties in sampling they do not truly represent the average of the batch. If the tests on the two portions agree that the specification is complied with, both buyer and seller are satisfied. If not, and after a second test they still do not agree, the buyer may call for a sample and test it himself. This sample, because it is separately drawn from the bulk, may differ from the previous one in its true sulphur-content. Thus, in addition to the so-called repeatability and reproducibility, a third source of variation may enter into the specification, namely, the variability of samples drawn from the same bulk.

By means of a diagram, Mr. Claxton explained how these sources of variation can operate to cause a batch to be accepted which is actually above specification in sulphur-content. He showed that the logical way of dealing with this is to achieve some measure of these variabilities and to set an arbitrary specification-limit lower than the actual tolerable maximum, thus ensuring that, even when the variability operates unfavourably, bulks above the tolerable maximum sulphur-content are rarely accepted. The Standardization of Tar Products Tests Committee is in process of making these measures of repeatability and reproducibility; but its figures have to be based on only a few results and are thought to be unnecessarily high. He entered a plea that the thousands of tests which are made annually in the routine of business might be modified so that by statistical analysis the estimates of variability might be extracted. This method of collecting information would have the advantage that the operators would not be tempted to spoil the estimates by taking special care, as they might with specially arranged tests.

Mr. R. G. Newton, of the British Rubber Producers' Research Association, spoke of the difficulty in rubber testing of achieving standard conditions of test, a difficulty which leads to high values of repeatability as well as of reproducibility. He quoted the case of a test for which repeat tests by the same operator made in quick succession varied more than tests made on different occasions. In this particular case the variability was traced to the effect of warming up the machine in which the rubber was mixed. Mr. Newton drew the conclusion that where so many causes of great variability exist, it is important to identify each and to estimate the variation to be attributed to each. Repeatability and reproducibility are all-embracing terms and are not sufficient in the case of rubber testing.

A routine analysis during production was discussed by Mr. A. E. Worley and Mr. C. E. Rhodes, of Reckitt and Colman, Ltd. They have found it necessary to employ several operators and to devise a routine of analysis which is quicker than ordinary standard methods and yet does not invite any lowering of standards of care on the part of the operator. Their methods have some originality, especially in their application to the chemical field, in that they first determined tolerable limits for the result of a test on an acceptable batch of products, and then adjusted the 'accuracy' of the test, relaxing where possible, so that batches of the product would be wrongly accepted only very rarely. This relaxing of accuracy effectively divides the presented batches into only three kinds: those below the tolerable lower limit for the test result, those within the tolerable limits and those above the higher tolerable limit.

This procedure can be thought of as equivalent to the engineer's use of a go-and-not-go gauge. By studying and measuring the various sources of variability in the test procedure, they were able to eliminate most of the variability between operators and to adjust the total effect of the other sources of variability to produce the required degree of accuracy. Their adjustment took the form, for example, of an alteration in the amount or strength of titrating fluid delivered by an auto-pipette. The important point is that the relaxation was not achieved by allowing slipshod methods, but only by broadening the classifications used to express the results. The relaxation is, as it were, under control and was only achieved after a study of the magnitudes of the various sources of variation. The authors of the scheme estimate that by its use they have achieved a reduction in the time taken for one test from five minutes to half a minute.

In the discussion, members of the audience were agreed that statistical analysis provides a useful means of interpreting the various sources of variation experienced in test results of all kinds, and that the estimation of the magnitudes to be attributed to the various sources (or groups of sources) is of value in control and interpretation. E. D. VAN REST

THE CHEMICAL RESEARCH LABORATORY, TEDDINGTON

THE report of the Chemistry Research Board for 1948, issued with the report of the Director of the Chemical Research Laboratory under the title "Chemistry Research 1948"*, like the report for 1938–46, which appeared last year, refers to both the long-term and the short-term aspects of the work of the Laboratory. After considering an important paper from the Director on the functions and future policy of the Laboratory, the Board decided to recommend that the general functions of the Laboratory should be: (*a*) to carry out objective fundamental chemical research including developmental work so far as this may be necessary to establish the industrial value of any discoveries which may be made; (*b*) to carry out appropriate chemical research on request and to provide technical advice to other sections of the Department of Scientific and Industrial Research, other government departments and British industry.

The Board thinks it appropriate that the work of a national research establishment should have this dual nature, but that a proper balance must be preserved between the two aspects. Mindful possibly of comments from the Select Committee on Estimates in regard to expenditure on research and development, the Board emphasizes that careful selection of topics in the programme of fundamental research is essential. Detailed consideration of the general policy which should determine the choice leads it to the opinion that long-range problems of chemistry or chemical technology, of a type which require attack by a skilled team over a long period, should be studied. The work should not duplicate that proceeding in British universities and industry, although duplication may not always be avoidable.

Five main themes are considered particularly appropriate for inclusion in the future programme of the Laboratory. First of these are researches leading to fundamental reference data of general value, such as precise data on the fundamental constants of pure chemical compounds. Second come new methods and techniques of chemistry in which it is desirable that an expert group should be maintained, particularly those which are so difficult or expensive as to be beyond the range of small research units. The Board recommended in 1944 that the Laboratory should pay particular attention to new techniques in its post-war programme, and subsequent developments have shown that this is one of the most useful fields in which the Laboratory can work. Next, the conservation of essential materials is recommended, with the objective of husbanding material resources, particularly key materials. Related to this is the utilization of indigenous raw materials, especially those of low grade, including wastes. The basic problems here are often technically difficult and demand long-term efforts for their solution. The main example of such work is to be found in that going forward at the Laboratory for the Ministry of Supply. Lastly, the investigation of potentially interesting new processes and materials is recommended.

The establishment of a Pure Metals Committee to stimulate interest in and co-ordinate the preparation of pure metals for research and development, and of a High Polymers Committee, under the chairmanship of Prof. H. W. Melville, in July 1948, are in line with these main themes. The Board, however, also undertook during the year a special review of current activities to ensure that the resources of the Laboratory were being applied in the most effective manner, having regard to the present national situation. It is agreed that it is necessary at present to ensure that every effort is made to apply scientific knowledge effectively, and that all possible help is given in the solution of current practical problems of importance in industry and government departments; but anxiety is expressed lest the fundamental research of the Laboratory may suffer in consequence.

In consequence of this change of plan, advisory and liaison work has increased in all sections, while in the re-organisation of the organic chemistry research of the Laboratory, the Coal Tar Section, which was one of the first major sections, has ceased to exist. In the re-orientation a prominent place has been assigned to the accurate determination of physical and physico-chemical data for pure organic compounds, and the Laboratory is developing its contact with the Hydrocarbon Research Group of the Institute of Petroleum. Prominence has also been given to investigations on the insecticidal properties of compounds derived from coal tar bases, the evaluation and development of acenaphthylene polymers and co-polymers, and new analytical procedures for certain coal tar compounds. A programme of work has been initiated on the preparation of isotopically labelled organic compounds; thus far the emphasis has been on the stable isotopes, and special procedures necessary for the manipulation and synthesis on the micro-scale of labelled compounds and simple intermediates containing carbon-13 have been evolved.

The Board refers particularly to the striking advances made at the Laboratory in the chromatographic separation of inorganic materials by a new technique involving the use of cellulose and other absorbing materials on one hand and of organic solvents containing additional reagents on the other, as well as to the concentration of effort by the High Polymers Section on problems relating to the ion-exchange and allied properties of synthetic resins. Considerable progress has been made in correlating the ion-exchange behaviour of polymers with their structure, and in the separation of pyridine and piperidine by the displacement–development technique on a cation exchange agent. Interesting results have been obtained from the study of the chemical reactivity of the chlorine atoms in polyvinyl chloride, particularly with ammonia and substituted ammonias. The discovery that, in the preparation of cold-setting resorcinol–formaldehyde adhesives, the technically pure resorcinol can be replaced by a crude resorcinol fraction from the low-temperature carbonization of coal provides a useful outlet for a virtual by-product.

Fuller details of these and other developments are given in the Director's own report. The Laboratory is now organised in four groups and an independent section, with an exploratory unit for investigations under the personal supervision of the Director. In the independent section, work carried out on polymers derived from bases other than hexamethylenediamine was being concluded; but the synthesis of long-chain compounds received considerable attention, including a continuous conversion of caproic acid to

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* Department of Scientific and Industrial Research. Report of the Chemistry Research Board, with the Report of the Director of the Chemical Research Laboratory for the Year 1948. Pp. vi+82+2 plates. (London: H.M. Stationery Office, 1949.) 2*s*. net.

n-decane by a modified Kolbe reaction, and decarboxylation studies on succinic anhydride and on unsaturated acids. In the Corrosion of Metals Group additional work has been carried out on the high-speed and low-speed rotor-technique under immersed conditions, while further studies of the relation between the electrical conductance and the area of breakdown of paint coatings on metal immersed in sea-water have shown that small areas of paint breakdown have a greater relative effect than large areas. Corrosion tests of about sixty low-alloy steels, using the intermittent spray apparatus, have been completed, and quantitative tests confirm that the depth of colour of the corrosion product and its adhesion to its steel basis are closely associated with the corrosion characteristics of the metal. Other work has been concerned with organic corrosion inhibitors such as sodium phthalate and sodium benzoate, both under immersed conditions and in wrapping materials. A temporary protective has been formulated based on rubber latex with sodium benzoate as inhibitor. The influence of surface pre-treatment and the composition and structure of oxide films on mild steel have also received attention, while the Microbiology Section has studied the culture and morphology of sulphate-reducing bacteria and the inhibitory action of antibiotics and antiseptics towards such bacteria, and established that mild but not stainless steel is corroded in cultures of such bacteria, as well as that such bacteria are a supplementary factor in the internal corrosion of water mains, especially in clay soils.

The Inorganic Group has given further attention to the extraction of gallium and germanium from flue dust, to the lower valency states of gallium and to the preparation of pure vanadium pentoxide, as well as to general techniques for extraction, microanalysis and spectroscopic analysis. The Radiochemical Group continued to work on the same lines as in the previous year, including analytical methods for the determination of uranium, thorium and other elements in raw materials, and the extraction, concentration and separation of valuable metals from mineral products. In the Organic Group, the Purification and Measurement Section continued its work on the separation of tar constituents, including the purification of pyridine and its homologues, and discovered some new colour reactions for individual bases in this group. A method for the determination of carbazole by nitrosation was developed, and the investigation on the formation of azeotropes between the phenolic and basic constitutions of tar distillates in the creosote oil range has been completed. The report includes a description and diagram of an apparatus in which low-boiling organic compounds can be transferred from part to part by low-temperature distillation and without contact with the atmosphere. An ebulliometer has been designed for use with a thermistor which may be subjected to either the vapour or liquid temperature. Some earlier work on acenaphthylene derivatives has been extended with a Beckmann spectrophotometer, and a Hilger double-beam infra-red spectrometer has been brought into use for qualitative and quantitative analysis.

In the first Organic Intermediates Section, besides work on the hydrogenation of pyridine, the hydrogenation of diphenylene oxide has been examined, and the study of co-polymers containing acenaphthylene extended. The second Organic Intermediates Section has prepared further quantities of methylchlorosilanes and methylethoxysilanes and obtained some success in attempts to produce silicone grease. A coating resin containing 1·35 methyl groups per silicon atom was intermediate in performance between two commercial resins as a waterproof coating for high-stability carbon resistors. Besides the work on carbon isotopes already noted, the Section prepared specimens of refined stearic acid, methyl stearate and copper, ferrous, ferric, lead and lithium stearates for the National Physical Laboratory, and developed further an apparatus for the simultaneous preparation and sublimation of aluminium chloride. In the independent High Polymers and Plastics Section, besides the work on the reaction of polyvinyl chloride and on ion-exchange properties stressed by the Board, the investigation of the sorption of water-vapour by phenol-formaldehyde film continued, and considerable progress was made in investigating the interlaminar strength of reinforced plastics.

Appended to the Director's report are lists of publications and patents during the year by members of the Laboratory, a list of staff and members of committees, and of lectures and colloquia in which the Director or staff participated.

FORESTRY IN TRINIDAD AND TOBAGO

IN the annual report for 1947 (recently published) of the Forestry Department of Trinidad and Tobago*, the conservator, Mr. G. N. Sale, says that the year was in many respects a watershed between the war-time and post-war periods, just as it has proved in other Empire forestry departments. The War has not been without its good aspects in some directions, and forestry and forests are one of them. A marked change of attitude has been noticeable among the local people. They had to buy, though unwillingly, home-grown timber during the War, as there were no timber imports; they have now become accustomed to it, and local saw-mills are no longer a novelty. An example can be seen in the demand for mora timber, the difficulties of exploitation of which were often complained of in annual reports in the pre-war 'thirties and discussed in reviews in *Nature* of the period; the demand for this timber, says the report, showed no signs of decreasing, and new areas must be made accessible for the continued supply.

It is curious that it has taken a Second World War to bring about this recognition of the value of its own forests to a country, both to the administration and to the people it governs. The principles of a forest policy formulated in 1942, the main features of which have so often been repeated throughout the Colonial Empire and outside it, are reiterated in this report. It is to be hoped that this repetition now-adays may no longer go unheeded. The shortage of experienced staff is mentioned and can be appreciated as the stumbling block to progressive advance in almost every branch of work mentioned in the report.

Trinidad and Tobago are not alone here, for there is scarcely a Colony of which the forestry staff has been anything near approaching the required strength for the past thirty years. It is this shortsightedness on the part of the authorities concerned which has delayed almost until the twelfth hour so much urgent forestry administration and forest research and settlement.

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* Colony of Trinidad and Tobago. Administrative Report of the Conservator of Forests for the Year 1947. Pp. 28. (Trinidad, 1949.)

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Groundnut Scheme in East Africa

MR. G. V. JACKS, in his review, published in *Nature* of December 24, 1949, of the first annual report of the Overseas Food Corporation, considers that, as disappointing as the beginning of the East African Groundnut Scheme has been, it could be considered a good one "had the scheme been laid down on a more moderate scale and carried out less extravagantly". May I be permitted to comment on this and to refer also to an editorial comment on the subject in *Nature* of December 31.

I would like to point out that when the Wakefield Mission was officially instructed before proceeding to Africa in June 1946, we were told, if the plan for the mechanized production of groundnuts presented to us was found to be feasible, to prepare a schedule for the production of not less than half a million tons of nuts annually by the end of five years. It was explained that the food position was extremely serious, particularly in regard to fats, vegetable oils and protein for cattle-feed; the fat shortage was regarded as a long-term problem. It should be remembered that at the time, even though supplies were available in North America to make up the loss of imports from Asia, dollars were short then as now, and 'Lend–Lease', which had carried us through the War, had been abruptly terminated. The present temporary alleviation through Marshall Aid was not in the picture; existing agricultural production could meet no more than half the current requirements of vegetable oil; the annual deficit to food-importing countries amounted to 2¾ million tons of oilseeds. Britain needed at least 1½ million tons and her major remaining source of supply, Nigeria, could produce only about 300,000 tons. The killing of whales is still limited by international agreement.

In consequence, Parliament, recognizing the risks of quickly opening up large new areas of production as well as the urgent necessity of such development, approved the plan as described in the White Paper (Cmd. 7030). Subsequent criticism has arisen, not because of the inception of the plan, but as a result of the refusal to recast it over a longer period and on a less ambitious scale, when it was obvious that the prerequisites to success were not forthcoming. It is the cost of 'buying time' which has been fantastically wasteful.

A more realistic programme was not decided upon until the autumn of 1948; but by then the project was committed to vast expenditure in staff and equipment planned on the basis of the White Paper.

Mr. Jacks's review, and numerous comments and letters published in the Press, give the impression that, so far, most of the *major* errors and problems have been on the agricultural side. This has not been the case, for the first plantings in 1947–48 were negligible and the crops of 1948–49 were ruined by a serious drought which affected a large part of the African continent. The failure of the period 1947–49 has been due to faulty organisation, lack of the requisite engineering experience, bad management of men and the insistent call for speed which ran down an inexperienced administration. Despite these discouragements, the achievements of the men and women in Tanganyika have been prodigious.

Mr. Jacks suggests that the "correct procedure would have been to gain experience on a pilot-plant scale before launching out on to the perilous seas of large-scale production". This raises a fundamental question which is as vital to the economic position of Britain as it is to the economic development and political aspirations of Central Africa: namely, can the problems of large-scale development be determined and solved by relatively small-scale agronomic experiment?

The experience of the great Sudan Gezira Scheme (undertaken only after ten years experimentation) has proved that a relatively small-scale pilot experiment is more likely to mislead than to give results which can be widely extended. The real problems did not emerge until large-scale operations had been carried out; and the problems appeared to be so insuperable that abandonment of the project was seriously considered within a few years.

In my view, a new and more courageous type of research is required, if the necessary areas of new production are to be brought into use in our time. It should be noted that Dr. E. B. Worthington has spoken in terms of 500 square miles for the pilot community development projects which he proposed for Uganda three years ago. The size of pilot mechanized projects must be large enough to bring out the problems of the deployment and maintenance in undeveloped country of large fleets of heavy tractors and bush-clearing equipment; the development and dispersal of suitable agricultural machinery; the control of pests and diseases; the maintenance of fertility over land where, because of the absence of surface and subterranean water, it is impossible to keep livestock; and the ecological planning of anti-erosion measures. On the all-important human side it must be able to bring out the administrative capacity of man, as well as the domestic problems of suddenly introducing large numbers of European men and women into the African bush. It must not ignore the impact on the African people of large-scale production. A wealth of information exists [illegible] Kongwa, of enormous value to the development of tropical Africa; but the staff are too occupied with their task to collate it.

These and other matters of vital importance to the ultimate success of the Groundnut Scheme, and to other development which the economic position of Britain demands, cannot be determined unless there is first an inquiry, as has been suggested in *Nature*, "by a body the impartiality and authority of which would command general confidence; and, from the scientific point of view, this is what matters most". When one considers the issues at stake and the lack of confidence in the London management, which persists to an alarming degree in the men on the job, it is incredible that the Government would refuse an inquiry to ascertain the fundamental causes of the difficulties and failures of the scheme.

A. J. WAKEFIELD

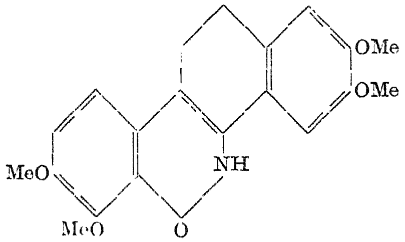
Sandhurst Farm,
Camberley.
Jan. 25.

Synthesis of a Reference Compound derived from Sanguinarine and Chelerythrine

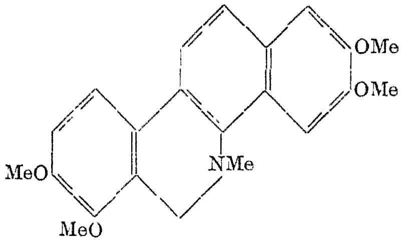
THE synthesis of 7 : 8 : 4′ : 5′-tetramethoxy-3 : 4-dihydro-1 : 2-benzphenanthridone (I) has already been reported[1]. By treatment with phosphoryl chloride, the change —CO—NH— → —CCl=N— was readily effected (found in the product, m.p. 176–178°; C, 65·2; H, 4·9; Cl, 9·9 per cent), and this chloro-compound, in boiling *p*-cymene solution, may be reduced by hydrogen in the presence of palladized carbon and simultaneously dehydrogenated to the related tetramethoxybenzphenanthridine (—CCl=N— → —CH=N— and loss of 2H by dehydrogenation, $—CH_2.CH_2— \rightarrow —CH=CH—$) (found in the product, m.p. 217–219°; C, 71·8, 72·1; H, 5·4, 5·3; N, 3·9 per cent).

The methosulphate of the latter base was changed by double decomposition into the methochloride, melting point 207–210° (found, C, 60·3; H, 6·2; Cl, 7·6 per cent, indicating $C_{22}H_{22}O_4NCl,2H_2O$), which is the tetramethoxy-analogue of sanguinarine chloride ($2CH_2O_2$) and chelerythrine chloride ($2MeO.CH_2O_2$).

On reduction with zinc in boiling aqueous hydrochloric acid, N-methyl-7 : 8 : 4′ : 5′-tetramethoxy-9 : 10-dihydro-1 : 2-benzphenanthridine (II) was produced.



I



II

This substance was obtained by Späth and Kuffner[2] from both dihydrochelerythrine and dihydrosanguinarine by hydrolysis of methylenedioxy groups followed by methylation.

We are deeply indebted to Dr. S. N. Sarkar for a specimen of this substance which he had prepared from dihydrosanguinarine.

The synthetic specimen crystallized in colourless prisms, melting point 182–184° (slight decomp.) (found, C, 72·6, 72·7; H, 6·5, 6·1; N, 3·9 per cent), and an intimate mixture with the specimen of natural origin (m.p. 183–185°) had melting point 183–185°.

A. S. BAILEY
R. ROBINSON
R. S. STAUNTON

Dyson Perrins Laboratory,
University, Oxford.

Nov. 9.

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[1] Bailey and Robinson, *Nature*, **164**, 402 (1949).

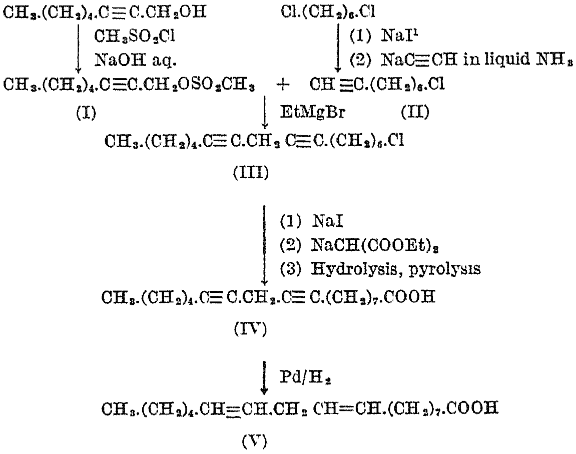
[2] Späth and Kuffner, *Ber. deut. chem. Ges.*, **64**, 2034 (1931).

Synthesis of Linoleic Acid

THE problem of the synthesis of the naturally occurring unsaturated aliphatic acids (nearly all of which possess the *cis* configuration about the double bonds) has only recently come under investigation in any detail. This is mainly due to the difficulty of obtaining, by classical methods, pure *cis*-ethylenic compounds. The present rapid development of acetylene chemistry, coupled with the fact that catalytic partial hydrogenation of the triple bond results in the formation of an ethylenic compound of *cis* configuration, has removed this stumbling-block, and the exploitation of this technique is being widely studied.

The recent work of Ahmad, Bumpus and Strong[1] has established an elegant method of striking simplicity for producing long-chain monoacetylenic acids of type $CH_3.(CH_2)_x.C{\equiv}C.(CH_2)_y.COOH$ and thence, by catalytic partial hydrogenation, the corresponding *cis*-ethylenic acids. At the moment, this certainly constitutes the best procedure for synthesizing the natural mono-ethylenic fatty acids (for example, oleic acid, erucic acid, etc.).

A great many of the natural polyethylenic acids contain the grouping *cis* : *cis*—$CH=CH.CH_2.CH=CH$—. One of the most important of these is the widely distributed linoleic acid (octadeca-9 : 12-dienoic acid) (V), the characteristic acid constituent of the semi-drying oils[2]; the substance has added interest by virtue of its properties as an essential food factor[3]. The obvious intermediate for the synthesis of this compound is the corresponding β-diacetylenic acid (IV). A review of the scanty literature on β-diacetylenes reveals the inaccessibility of these compounds; only a few hydrocarbons of this series have been obtained, and these in poor yield owing to the reactivity of the methylene group situated between the triple bonds[4].



$$\begin{array}{lcl} CH_3.(CH_2)_4.C{\equiv}C.CH_2OH & & Cl.(CH_2)_6.Cl \\ \quad\downarrow CH_3SO_2Cl,\ NaOH\ aq. & & \quad\downarrow (1)\ NaI^1\ (2)\ NaC{\equiv}CH\ in\ liquid\ NH_3 \\ CH_3.(CH_2)_4.C{\equiv}C.CH_2OSO_2CH_3 & + & CH{\equiv}C.(CH_2)_6.Cl \\ (I) & \downarrow EtMgBr & (II) \end{array}$$

$$CH_3.(CH_2)_4.C{\equiv}C.CH_2\,C{\equiv}C.(CH_2)_6.Cl \quad (III)$$

$$\downarrow (1)\ NaI\ (2)\ NaCH(COOEt)_2\ (3)\ Hydrolysis,\ pyrolysis$$

$$CH_3.(CH_2)_4.C{\equiv}C.CH_2.C{\equiv}C.(CH_2)_7.COOH \quad (IV)$$

$$\downarrow Pd/H_2$$

$$CH_3.(CH_2)_4.CH{=}CH.CH_2\,CH{=}CH.(CH_2)_7.COOH \quad (V)$$

We have been successful in obtaining the required β-diacetylenic acid intermediate (IV) by the route indicated. An ethereal solution of the Grignard complex of the acetylenic chloride (II) was very slowly added to a boiling ethereal solution of an excess of the acetylenic methanesulphonate (I). This condensation procedure ensured that no excess Grignard reagent was present at any time to attack the central methylene group of the product (III). Conversion of the latter to the iodide, followed by the familiar malonic ester chain-lengthening process, yielded the required β-diacetylenic acid (IV) as glistening plates, melting point 42–43°. Unfortunately, the high temperature needed for decarboxylation caused considerable resinification, and the yield of acid (IV) was correspondingly low; investigations to obviate this difficulty are now in progress.

A preliminary catalytic partial hydrogenation of the acid (IV) furnished a yellow oil which was identified as linoleic acid (V) by formation of its solid tetrabromide, melting point 112–113°, and by complete hydrogenation to stearic acid.

This work is being expanded and will be fully reported elsewhere. We are indebted to Sir Ian Heilbron and Prof. E. R. H. Jones for their interest in this work, which was carried out during the tenure of an I.C.I. Fellowship (R. A. R.) and a senior award of the Department of Scientific and Industrial Research (F. S.). Thanks are due to the Chemical Society for a research grant.

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FRANZ SONDHEIMER

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London, S.W.7.
Sept. 23.

[1] *J. Amer. Chem. Soc.*, **70**, 1699, 3391 (1948).

[2] Ralston, A. W., "Fatty Acids and their Derivatives" (Chapman and Hall, London, 1948).

[3] Rosenberg, H. R., "Chemistry and Physiology of the Vitamins", 531 (Interscience Publishers, New York, 1942).

[4] Grignard, V., and Lapayre, L., *C.R. Acad. Sci., Paris*, **192**, 250 (1931). Tchao Yin Lai, *Bull. Soc. Chim.*, **53**, 1537 (1933).

Preparation of Ethynylcarbinols from the Bisulphite Compounds of Aldehydes and Ketones

WHEREAS a variety of methods for the preparation of ethynylcarbinols from both saturated and unsaturated carbonyl compounds have been described[1], we have traced only one reference[2] in the literature to the preparation of diethynyl glycols, from dicarbonyl compounds and acetylene. While this work was in progress, Milas *et al.*[2] reported the preparation of the diethynyl glycols from diacetyl and acetonylacetone.

While aliphatic dialdehydes in particular are not easily accessible materials of low stability, their bisulphite compounds can frequently be obtained in a pure crystalline condition, and we find their purity readily determined by weighing the washed and dried precipitate formed by treatment with an excess of a standard solution of 2 : 4-dinitrophenylhydrazine sulphate.

We have now found that reasonable yields of ethynylcarbinols can be obtained from the bisulphite compounds of aldehydes and ketones by reaction with sodium acetylide in liquid ammonia. By this means the following pure ethynylcarbinols have been prepared in the yields stated: dimethylethynylcarbinol in 45 per cent yield, *n*-butylethynylcarbinol (32 per cent), phenylethynylcarbinol (45 per cent) and styrylethynylcarbinol (12 per cent), from the crystalline sodium bisulphite compounds of acetone, *n*-butaldehyde, benzaldehyde and cinnamaldehyde respectively. Styrylethynylcarbinol has previously been obtained in only 2 per cent yield[3] by reaction of cinnamaldehyde with sodium acetylide in liquid ammonia, and the method thus represents an improvement in this case.

Full details will be reported elsewhere; the application of the method to dicarbonyl compounds is under investigation.

J. CYMERMAN
K. J. WILKS

Department of Organic Chemistry,
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Sept. 22.

[1] Johnson, "The Chemistry of the Acetylenic Compounds" (Edward Arnold, London, 1946).

[2] Milas, Brown and Phillips, *J. Amer. Chem. Soc.*, **70**, 2862 (1948).

[3] Jones and McCombie, *J. Chem. Soc.*, 733 (1942).

Effect of Light on the Reaction between Periodates and α-Glycols

SINCE the original discovery by Malaprade of the cleavage of α-glycols by periodic acid and its salts, the reaction has been widely and increasingly used in the solution of structural problems connected with the carbohydrates. The course of the main Malaprade reaction with α-glycols and various compounds of similar type is well known, and the consumption of periodate is usually stoichiometric; but the literature contains many references to examples of so-called 'over-oxidation', or 'over-utilization', of periodate.

The cause of this may well vary from case to case; for example, I have shown[1] that whereas β-methyl glucoside and β-methyl cellobioside are oxidized stoichiometrically at $pH < 5$, very substantial over-oxidation occurs when the solutions are made alkaline. A factor of more general importance, which does not seem to have been noted hitherto, is the effect of light upon the course of the reaction.

Jackson and Hudson[2] and Davidson[3] observed that the amount of periodic acid or sodium *meta*periodate consumed in the oxidation of cellulose did not cease at the 'theoretical' value of one mole per C_6 unit, and figures as high as 1·22 for cotton and 1·86 for filter paper were reported. Davidson noted, too, the formation of considerable quantities of formic acid, formaldehyde and carbon dioxide, and it was evident that side reactions were occurring with both oxidants.

However, when I repeated Davidson's oxidation of cotton with sodium *meta*periodate, I found that the reaction virtually ceased when one mole of oxidant had been consumed (about twenty days at 20°), and even at the end of forty-one days the consumption was only 1·06 moles. A possible explanation of this discrepancy seemed to be that various chance circumstances had resulted in the almost complete shielding of the reaction mixture from light.

It has now been observed that with 1·6 moles of sodium *meta*periodate per C_6 unit, the oxidation of cotton at room temperature, and in the complete absence of light, virtually ceased when one mole of periodate had been consumed (about seventeen days in a particular experiment). When the reaction mixture was contained in a clear glass bottle accessible to bright daylight, oxidation was much more rapid and continued until all the available periodate had been consumed (1 mole after six days and 1·6 after eighteen days). With a much larger excess of periodate (3·7 moles $NaIO_4$ per C_6 unit) the consumption reached one mole in four days and 3·7 in twenty-five days when bright daylight was accessible to the reaction mixture.

The disappearance of periodate is followed in all cases by the appearance of free iodine; carbon dioxide can be detected, and the insoluble oxidized cotton has an appreciable carboxyl content not to be accounted for on the basis of the accepted mechanism of oxidation.

Similar results have been obtained for the oxidation of β-methyl glucoside and β-methyl cellobioside with sodium *meta*periodate. With a large excess of oxidant, the reaction does not terminate when the consumption of periodate and production of formic acid have reached the limits set by the classical Malaprade reaction, unless the experiment is carried out in complete darkness. In bright daylight, oxidation proceeds more rapidly and goes very much further.

There are very great variations in the rates of oxidation of different α-glycols (carbohydrates, glycosides, etc.) by periodate. It is probable that the disturbance of the normal reaction caused by irradiation is most pronounced when the 'dark reaction' is relatively slow, as it is in the oxidation of cellulose.

It is worthy of note that solutions of sodium *meta*periodate are themselves unstable when kept in bright daylight (for example, the concentration of a 0·03 M solution fell by about 10 per cent during fifteen days), and the odour of ozone first observed by Rammelsberg[4] is very pronounced. Solutions kept in the dark are both odourless and stable; illuminated reaction mixtures of sodium *meta*periodate with cotton or the glycosides do not smell of ozone.

Such evidence as is yet available points to the occurrence of far-reaching degradation during the photochemical reaction. The investigation of the subject is being continued in these laboratories.

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Sept. 20.

[1] *J. Text. Inst.*, **38**, *T*389 (1947).
[2] *J. Amer. Chem. Soc.*, **59**, 2049 (1937).
[3] *J. Text. Inst.*, **32**, *T*109 (1941).
[4] *Pogg. Ann.*, **134**, 534 (1868).

Isolation of a Saponin from the Heart-wood of the Mora Tree and of a Related Species, Morabukea

In the course of a chemical examination of the wood of the mora tree, *Mora excelsa* (Benth.), from British Guiana and from Trinidad, we observed that the heart-wood contains an unusually high proportion of material soluble in water or alcohol, of which up to about one-half was found to consist of a saponin.

The saponin is most readily isolated by exhaustive extraction of the wood with hot alcohol, evaporation of the alcoholic liquor nearly to dryness, and trituration of the dark-coloured syrup with an excess of hot acetone. The colouring matter and other impurities pass into solution in the acetone, leaving a light-coloured amorphous solid, which is separated and purified by further treatment with acetone. The saponin is finally obtained as a very pale buff- or pink-coloured powder, the aqueous solution of which exhibits intense foaming properties. The saponin content of the heart-wood of a number of samples of mora from British Guiana was found to lie between 2·8 and 9·6 per cent, based on the dry weight of the wood. A saponin has also been found in the heart-wood of mora from Trinidad, and of the related species morabukea (*Mora gonggrijpii* (Kleinh.) Sandwith); but these woods have not been examined quantitatively. Although saponins are known to occur in small quantities in the wood of the boles of a few tree species[1], the wood of mora may prove to be a relatively rich source.

On hydrolysis with 6 per cent alcoholic hydrochloric acid for 30 min. at the boiling point, mora saponin yielded 21·4 per cent of a crude crystalline aglycone. Fractional crystallization of this product from ethyl alcohol resulted in the isolation, first, of a crystalline sapogenin of melting point 269–270° and $[\alpha]_D + 29{\cdot}5°$ ($c = 0{\cdot}83$ in chloroform) in a yield of 9·4 per cent of the dry weight of the original saponin (found: C, 76·67; H, 10·63 per cent). This sapogenin readily forms a monoacetate of melting point 255–257° (found: C, 76·91; H, 10·14 per cent). At least one other crystalline sapogenin is known to be present in the hydrolysis product of the original saponin. These substances are being further examined by Dr. D. H. R. Barton, to whom we are indebted for the suggestion that the principal sapogenin of melting point 269–270° is a new triterpenoid hydroxy-carboxylic acid.

Hydrolysis of mora saponin with 5 per cent aqueous sulphuric acid at 95° for 4 hr. gave a mixture of sugars from which the aglycone was separated by filtration. After neutralization of the filtrate with barium carbonate and evaporation to dryness, the sugars were extracted with 90 per cent ethyl alcohol and isolated as a concentrated syrup. Examination of the syrup by partition chromatography on paper[2] revealed the presence of two sugars, which were probably glucose and xylose.

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Oct. 3.

[1] Wise, L. E., *et al.*, "Wood Chemistry", 436 (Reinhold, New York, 1944).
[2] Partridge, S. M., *Nature*, **158**, 270 (1946).

Preparation of Carbonate-free Sodium Hydroxide

We have been studying the carbonate – hydroxide ion exchange on the strong base resin 'Amberlite IRA-400' (manufactured by Rohm and Haas Company and supplied by Messrs. Charles Lennig and Co., Ltd., 1–11 John Adam Street, London, W.C.2). It was expected that the bivalent ion would be preferentially held by the resin, and this is so. The following figures show the results of bringing the resin in the carbonate form into equilibrium with various sodium hydroxide solutions.

$(CO_3/OH)_R$	$(CO_3/OH)_S$	Total conc.
1·37	0·062	0·0976
2·16	0·095	0·04912
3·82	0·167	0·0196

The first two columns give the carbonate – hydroxide ratios at equilibrium, in the resin and in the corresponding solution, measured in equivalents, and the third the total concentration of the solution in gram-equivalents per litre.

An efficient chromatographic separation of carbonate and hydroxide is clearly possible, and offers a very simple method of preparing the carbonate-free alkali continually needed for volumetric work and in the preparation of buffer solutions. Rather more than the required amount of alkali is made up, without special precautions, from washed sticks, and a column of the resin, which may be initially in the form of its chloride, is prepared in the usual way. The capacity of the air-dry resin is 1·4 milli-equivalents per gram, and a 50-ml. tube two-thirds full of the resin would be suitable for preparing 1 litre of 0·1 N sodium hydroxide. The alkali is passed through the resin until the effluent is chloride-free (if necessary), and the tube is then transferred to the neck of the stock bottle. When the rest of the alkali has passed through, the resin column is replaced by a sodalime guard tube, and the carbonate-free sodium hydroxide is ready for standardization.

The direct replacement of carbonate in the exhausted resin by hydroxide is difficult, but the column can be easily regenerated by the passage of hydrochloric acid, which destroys the carbonate, and the subsequent replacement, as described, of the chloride by hydroxide.

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Recrystallization of Regenerated Cellulose upon Mercerization

IN a recent paper[1], it was shown by application of a quantitative X-ray method[2] that viscose rayon fibres, upon boiling with 2·5 N sulphuric acid, exhibit a distinct increase in crystallinity from 40 per cent initially to nearly 50 per cent, which is terminated within half an hour. The decrease of water sorption after the treatment was in line with this result.

It has now been found that a similar recrystallization can be effected by 'mercerization'. Four different rayon fibres were soaked in 18 per cent caustic soda solution at room temperature for 10 min., freed from lye by pressing between filter paper, and put into a large quantity of boiling water to remove the residual caustic soda. After rinsing with dilute acetic acid and then water, the fibres were dried in the air.

The loss in weight owing to the previous operations amounted to 3–6 per cent. Examination with X-rays (method of ref. 2) of four different rayon samples thus treated yielded a percentage crystallinity varying between 50 and 55 per cent (taking into account the small loss in weight), and thus an even somewhat larger increase than that obtained by acid hydrolysis.

The recrystallization upon acid hydrolysis has tentatively been explained as follows. Cutting of part of the chains in the amorphous regions of the irregular partly crystalline network structure in the cellulose gel may remove part of the entanglements, or restore some of the inhibited segmental freedom of movement and rotation which prevent further growth of the crystalline regions. It remains to be investigated whether the result of the mercerization experiments can or cannot be explained in a similar way.

Experiments repeated in an oxygen-free atmosphere and thus excluding chemical degradation will be required in this connexion. Further work along this and other lines is in progress.

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Sept. 19.

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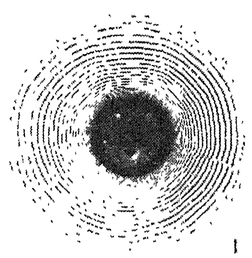
[1] Hermans, P. H., and Weidinger, A., *J. Polymer Sci.*, **4**, 317 (1949).

[2] Hermans, P. H., and Weidinger, A., *J. App. Phys.*, **19**, 491 (1948); *J. Polymer Sci.*, **4**, 135 (1949).

Electric Potential of Solutions as a Cause of the Formation of Liesegang Rings

FOLLOWING our experiments in relation to the influence of electric current on the formation of Liesegang rings, it has been found that silver nitrate (diluted) drops on chromogelatine cause a potential difference of nearly 80 millivolts. The silver nitrate has a positive, and the chromogelatine a negative, potential. This potential difference lasts only so long as silver dichromate is being formed. At first it decreases very quickly, and at the same time with the quick appearance of the rings; later, the rate of decrease becomes slower, parallel with the slower formation of the rings. If the silver nitrate–chromogelatine pair is short-circuited (by short-circuiting the electrodes), then a change is observed in the appearance of the Liesegang rings; normal rings are shown in Fig. 1 and modified rings in Figs. 2 and 3.

The short-circuit causes a much more rapid decrease of the potential difference, although it still lasts more than fifty hours. Therefore, we have tried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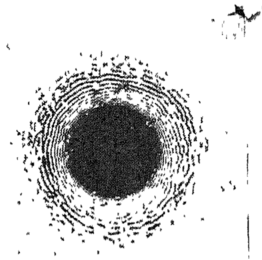
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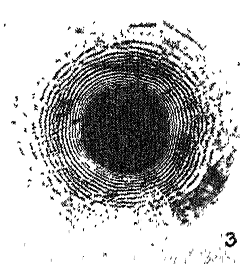
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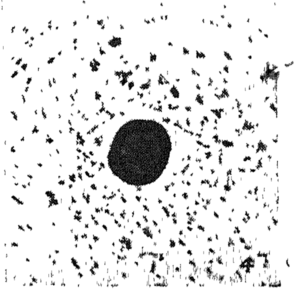
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to get a better short-circuit by using instead of a glass plate a silver plate, so that there can no longer be any difference of potential between the chromo-gelatine and the drops of silver nitrate. In these circumstances, the formation of Liesegang rings has not been observed; the formation of the periodic precipitate ceases, and instead of it a homogeneous diffuse precipitate appears (Fig. 4). This shows that the formation of a periodic precipitate in an isotropic colloidal medium is very similar to the phenomena of liquid-contact potentials. On eliminating this potential, periodic precipitation does not occur.

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Dipole Moments of some *Ortho*-Substituted Anilines

WE have measured the dipole moments of aniline, N-methyl aniline, N,N-dimethyl aniline, and corresponding toluidines and xylidines. As is seen from the accompanying table, alkylation affects the dipole moments of aniline and *p*-toluidine to a small extent, the difference in dipole moment between the primary and the tertiary amines being about 0·05 Debye. In the case of *ortho*-substituted amines, however, the substitution of two methyl groups at the nitrogen atom lowers the dipole moment by about 0·7 Debye. The dipole moments of these tertiary aniline homologues have almost the same value as that of aliphatic tertiary amines, namely, 0·8 Debye[1]. This result is in good agreement with the result obtained by Thomson[2] from measurements of molecular refractivities. He calculated that the atomic refractivity of nitrogen in dimethyl 2,6-xylidine approaches very closely the value for nitrogen in a tertiary aliphatic amine. Furthermore, Remington[3] has found from ultra-violet absorption spectra that the resonance is inhibited in *ortho*-substituted derivatives of dimethyl aniline.

	μ	Δ
Aniline	1·59	0 04
Dimethyl aniline	1 55	
p-Toluidine	1 35	0·05
Dimethyl *p*-toluidine	1 30	
o-Toluidine	1·60	0·7
Dimethyl *o*-toluidine	0 9	
2,4-Xylidine	1 34	0 6
Dimethyl 2,4-xylidine	0 7	
2,6-Xylidine	1·65	0·7
Dimethyl 2,6-xylidine	1 0	

The investigation of the dipole moments of the monomethyl aniline derivatives, which is being continued in this laboratory, does not show any pronounced difference between the *ortho*-substituted secondary amines and the corresponding non-substituted one. Full details of the measurements will be published elsewhere.

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Sept. 20.

[1] Ghosh, P. N., and Chatterjee, T. P., *Phys. Rev.*, **37**, 427 (1931).

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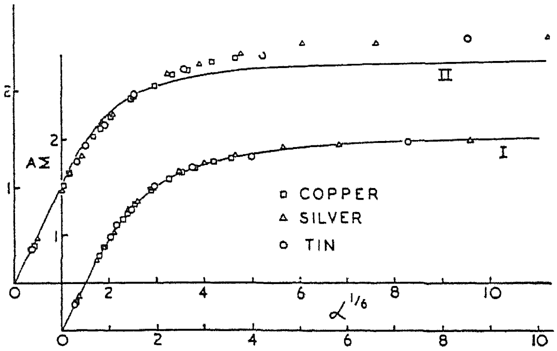
[3] Remington, W. R., *J. Amer. Chem. Soc.*, **67**, 1838 (1945).

Anomalous Skin Effect in Metals

AT sufficiently low temperatures and high frequencies, the mean free path of the electrons in a good conductor becomes greater than the classically predicted skin depth, and the classical skin-effect equations break down. Pippard[1] has studied the effect at liquid helium and liquid hydrogen temperatures, and Reuter and Sondheimer[2] have given the quantitative theory of the effect, and have interpreted Pippard's results. They found that for tin, mercury and aluminium, the experimental results implied reasonable values for the ratio σ/l of conductivity to electronic mean free path, but that for copper, silver and gold they implied values lower than the expected values by a factor of 5 or more. It was suggested that these low values were due to surface conditions differing from those in the bulk metal. In order to study this suggestion and to make a more detailed comparison with the theory than was possible on the basis of Pippard's measurements, a new investigation has been carried out in which attention has been paid to surface conditions, and the whole temperature range from 2° K. to 90° K. has been covered.

An electrically heated cryostat was built, capable when immersed in a bath of liquid helium or liquid hydrogen of maintaining any temperature between 2° K. and 90° K. for an indefinite period. The radio-frequency conductivity of the specimens was measured at about 1,200 Mc./s. by the method used by Pippard, and simultaneous measurements of the D.C. conductivity were made on similar specimens.



I, Experimental points fitted to $p = 0$ curve. II, Attempt to fit to $p = 1$ curve. Full lines theoretical

Measurements have so far been made on tin, cast in silica capillaries, and copper and silver, electrolytically polished. For all specimens, the results indicate that reflexion of electrons at the surface is completely diffuse, at all temperatures. The accompanying graphs show typical results on three specimens, scaled (I) to fit the theoretical (Reuter and Sondheimer) curve for completely diffuse reflexion ($p = 0$), and (II) in an attempt to fit the curve for specular reflexion ($p = 1$). It might have been expected that the 'reflexion coefficient' p would rise as the temperature was lowered and thermal disturbances at the surface became smaller: that this is not observed presumably indicates permanent surface irregularities of the order of magnitude of the electronic wave-length, that is, a few angstroms. The Reuter and Sondheimer curves relate two variables $A\Sigma$ and α; here $A\Sigma$ is proportional to the observed Q of the specimen, the scaling factor depending on the geometry of the resonator and the constant of the metal, and $\alpha = 3l^2/2\delta^2$, where l is the mean free path and δ the classical skin depth. Hence $\alpha^{1/3} \propto \sigma$, the D.C. conductivity; the constant of proportionality differs from metal to metal, and from it may be found the 'free-electron' values of σ/l and also of n_e/n_a, the effective number of conduction electrons per atom. The values thus deduced from the experiments on tin, copper and silver are given in the accompanying table (specimens Sn, Cu, Ag); the probable errors of these figures are about ± 5 per cent. Also given, for comparison, are the results deduced from Pippard's measurements (Sn (P), etc.), which have rather larger probable errors, and from measurements on two other specimens treated as described below (Cu A, Cu B).

Specimen	σ/l (ohm^{-1} cm^{-2} × 10^{10})	n_e/n_a
Sn	9·5	1·1
Sn (P)	8·0	0·87
Ag	9·0	0·66
Ag (P)	1·7	0·052
Cu	17·0	1·17
Cu (P)	2·8	0·1
Cu A	2·9	0·1
Cu B	15·0	0·97

It will be seen that for tin the present results are of the same order as Pippard's result Sn (P), but that for copper and silver the present figures are much higher and much closer to the expected figures. Whereas Pippard's specimens were annealed but otherwise left unaltered after drawing down to the required diameter, specimens Cu and Ag were electrolytically polished to remove the surface layer. Two mechanisms have been suggested to account for the effect of the surface layer: (i) roughness, and (ii) increased resistivity owing to cold-work during drawing, not removed by subsequent annealing. To decide between these, specimens Cu A and Cu B were measured. Cu A, a specimen previously measured in the electro-polished condition, was treated with 'Brasso' metal polish. The surface still appeared to be very highly polished, but the effect on σ/l and n_e/n_a was drastic; they were reduced to about the same values as for Cu (P). Specimen Cu B, also previously electropolished, was dipped in nitric acid for a few moments, which produced a dull mat surface, showing under the microscope considerable roughness of the required order of magnitude, that is, a few thousand angstroms. It will be seen, however, that the effect on σ/l and n_e/n_a is small. It is therefore concluded that the predominant cause of high surface losses is a high-resistance surface layer. By analysing the form of the curve for Cu A, it was possible to deduce on this assumption that the surface layer extended for more than 2,000 angstroms below the surface, and had a residual resistivity about ten times that of the bulk metal.

Experiments are in progress on gold and the alkali metals, and also on metals other than Group I metals.

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Nov. 10.

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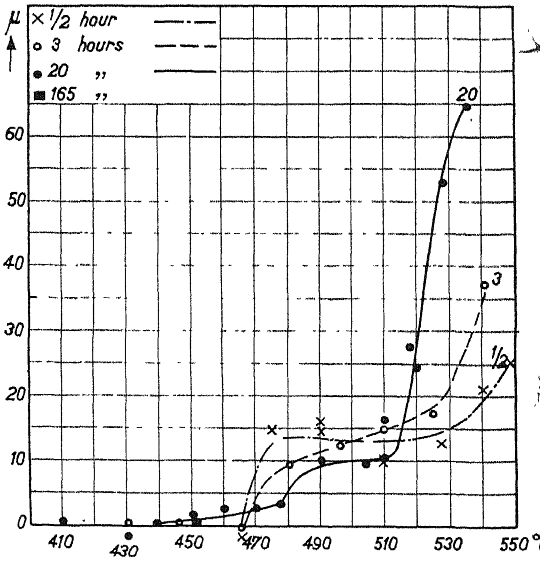
Rapid Oxidation of Metals and Alloys in the Presence of Molybdenum Trioxide

IN studying heat-resistant iron-base and copper-base alloys at 750° C., we observed a pronounced increase of the rate of oxidation, when the atmosphere was contaminated by molybdenum trioxide vapour. In the meantime, this effect has been discovered independently by Leslie and Fontana[1], who observed above about 800° C. a rapid oxidation of steels with a high content of molybdenum. These authors ascribed the abnormal oxidation to a catalytic action of molybdenum trioxide, the thermal dissociation into molybdenum dioxide and nascent oxygen being the important factors in their opinion.

In connexion with the low melting point of molybdenum trioxide (790° C.) we wished to settle the question whether a liquid oxide phase hampers the development of a protective oxide film, thus causing the rapid oxidation. To this end we studied the temperature-dependence of the influence of molybdenum trioxide on the oxidation of different metals and alloys. Here we wish to restrict ourselves to a description of the influence of the trioxide on the oxidation of aluminium-copper, copper, silver and aluminium–silver. These materials are especially interesting because molybdenum trioxide markedly influences their rate of oxidation at such low temperatures (below 500° C.) that the thermal decomposition of molybdenum trioxide can be disregarded. At these temperatures even the vapour pressure of molybdenum trioxide is very small (at 500° C., ~ 10^{-5} mm. mercury). Therefore the oxidation was carried out in such a way that the metallic specimens were at the same time in contact with air and with the trioxide powder. Weighing experiments, micrographic analysis and tensile tests of oxidized wires gave reasonable agreement as to the effective depth of penetration d, caused by the action of molybdenum trioxide. The values of d determined for 8/92 aluminium–copper in the accompanying graph refer to tensile tests and are defined as $d = r_0 (1 - \sqrt{K_M/K_A})$, where r_0 is the original radius of the wire, while K_M and K_A are the forces required to rupture the wires



Penetration depth on oxidizing 8/92 aluminium–copper wires in the presence of molybdenum trioxide at different temperatures heated for the same time and temperature with molybdenum trioxide and in pure air respectively.

Above 470°, molybdenum trioxide influences the oxidation of aluminium–copper (which is negligible in pure air up to 750° C.), while a subsequent sharp increase is seen, as for *OFHC* copper, near 530° C. In agreement with this, liquid was found in mixtures prepared from molybdenum dioxide and trioxide and cuprous oxide above 470° C., while the trioxide and cuprous oxide form a eutectic at 530° C.

For silver and its alloys, molybdenum trioxide was found to influence the rate of oxidation at temperatures well below 400° C., while the lowest eutectic for mixtures of molybdenum dioxide and trioxide and silver molybdate was found near 490° C. However, the case of silver and its alloys is more complicated. At atmospheric pressure pure silver can only be oxidized above 180° C. if silver oxide is stabilized by other oxides[2], for example, by the formation of silver molybdates (we found that silver molybdate melts without decomposition in air at 570° C.). Hence molybdenum trioxide influences the rate of oxidation of silver alloys even when no liquid is formed.

The surface conditions of specimens oxidized in the presence of the liquid oxide mixtures were examined. In the case of aluminium–copper, a layer of pure copper appears on the former surface. A corresponding phenomenon was observed by Hallowes and Voce[3] in corrosion experiments with steam contaminated with sulphur dioxide. In the case of 4/96 aluminium–silver, layers of pure silver alternate with oxide layers. The liquid forms first at some weak spots of the protective aluminium oxide layer present on these alloys, which leads for a fixed temperature to a rate of oxidation which increases with time.

It might be supposed[4] that in the presence of liquid the attack will be mainly intergranular. In fact, there was always a preference for grain boundaries, but a separation of grains along high-energy boundaries only—not twin boundaries—was found in the case of silver.

In connexion with the influence of molybdenum trioxide on the oxidation of stainless steels already referred to, it may be mentioned that iron- and molybdenum-oxides form a eutectic near 730° C. This seems to agree with our view that the occurrence of a liquid oxide phase is the determining factor, not the dissociation of molybdenum trioxide.

A full account of the experiments is to appear in *Philips Research Reports*.

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Eindhoven. Sept. 15.

[1] Leslie, W. C., and Fontana, M. G., *Trans. Amer. Soc. Metals*, **41**, 1213 (1949).

[2] See Schenk, R., *Z. anorg. allg. Chem.*, **249**, 88 (1942).

[3] Hallowes, A. P. C., and Voce, E., *Metallurgia*, **34**, 119 (1946).

[4] Smith, C. S., Metals Technology Technical Publication 2387 (June 1948).

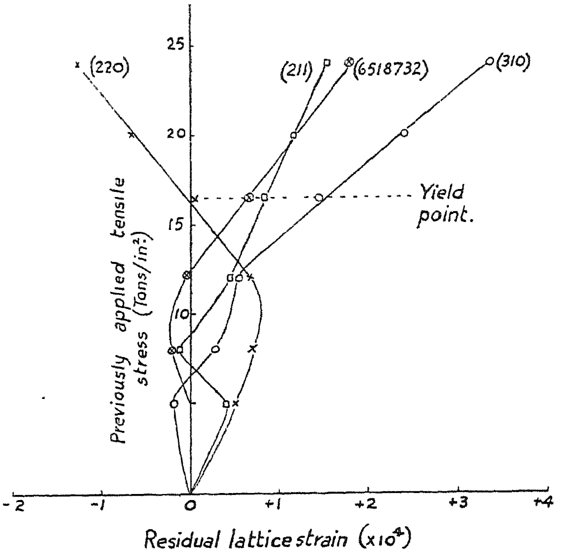
Residual Lattice Strains in Mild Steel

While it is established from the work of Wood[1] and others that, after plastic deformation of a polycrystalline metal aggregate, residual lattice strains are left in the individual grains at normal temperature, considerable speculation still exists as to the origin and distribution of these strains. It is customary to apply X-ray diffraction methods to this problem, and as has often been pointed out, owing to the selective properties of the X-ray technique, the strain measured, using any particular X-radiation, is a mean of the lattice strains in only those grains in the aggregate which are suitably oriented to reflect the incident beam. By using different radiations, Greenough[2,3] has shown for a number of metals that residual lattice strains in plastically extended aggregates are present which vary in both magnitude and sign, depending upon the orientation of the particular grains examined.

Recently, Greenough[3] has put forward a quantitative hypothesis to explain these results, based on a concept originally introduced by Heyn[4] to explain creep recovery. The explanation involves the assumption that, in a randomly oriented polycrystalline aggregate deforming under, for example, a tensile stress, some grains, in which the glide planes and glide directions are suitably oriented with respect to the stress direction, will yield before their neighbours which have different orientations. In consequence, if the applied stress is removed, grains with a high yield-tension will be left in tension and those with a low yield-tension in compression. If these effects occur on a scale which is alone sufficient to explain the residual lattice strains observed, it should be possible by X-ray methods to detect disorientation in given families of grains in a polycrystalline aggregate at differing values of applied stress.

Experiments have been carried out in this Laboratory to test this point on mild steel. Flat bars machined from a sample of a 0·14 per cent carbon steel (B.S. Specification 2*S*14) were first annealed and electrolytically polished to produce a high degree of grain perfection as shown by sharpness of the X-ray reflexion spots, and then subjected to a series of homogeneous, uniaxial tensile loads in an Amsler machine. After each load, the bar was removed and examined in a precision X-ray back-reflexion camera, with the incident beam at both normal and an oblique angle of incidence to the surface, before being subjected to the next load. By using cobalt, chromium, molybdenum and iron radiations, reflexions were obtained from six families of ferrite grains in which the 211 (Cr $K\alpha$), 220 (Fe $K\alpha$), 222 (Co $K\beta$), 310 (Co $K\alpha$, Fe $K\beta$), 651 or 732 (Mo $K\alpha$) and the 800 (Mo $K\alpha$) reflecting normals were approximately perpendicular to the surface of the bar and the stress direction for normal incidence, or made known angles for oblique incidence of the X-ray beam. In the neighbourhood of the yield-point for the material, the increments of stress between each successive load were narrowed to 0·5 ton/in.^{2} to fix the yield-point within small limits. It was found that all the X-ray patterns from the different radiations for both normal and oblique incidence exhibited uniform breakdown of the grains for the *same* value of previously applied stress (16·5 ton/in.^{2}). After loading to 16·5 ton/in.^{2}, one of the bars was electrolytically polished to reduce its thickness by 0·008 in. and then re-examined in the X-ray camera. All the families of grains examined previously still exhibited the onset of disorientation in the grains, showing the effect was not confined to the surface layers.

In addition to taking stationary photographs for the test just described, a series of patterns was also obtained for normal incidence of the X-ray beam, in which the specimen was oscillated through $\pm 2\frac{1}{2}°$ to enable residual lattice strains to be determined. Particular care was taken in the experimental technique to reduce sources of error to a minimum.



Typical results obtained are shown in the accompanying figure, the probable error in lattice-strain varying from about $\pm 1 \times 10^{-5}$ to $\pm 3 \times 10^{-5}$, depending on the planes examined. For present purposes, the point of interest which emerges is that the family of grains in which the (220) reflecting normals are approximately perpendicular to the direction of previously applied stress not only exhibits negative residual lattice strains after breakdown of the grains has occurred (as shown by the stationary photographs), in agreement with previously published results[2], but also positive strains for lower values of stress. It will be observed that all the spacings measured showed evidence of small but detectable residual strains for previously applied stresses well below the nominal yield-point. Similar effects have been observed for other stress versus lattice strain experiments which are in progress, and will be discussed in detail elsewhere.

It is difficult to explain these effects solely on the basis of a system of Heyn stresses arising from the interaction between any grain and its neighbours. Further work is being carried out in an attempt to sort out the relative importance of various influences which may account for these results.

R. I. GARROD

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Victoria, Australia.
Sept. 22.

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[1] For example, Wood, W. A., *Proc. Roy. Soc.*, A, **192**, 218 (1948).

[2] Greenough, G. B., *Nature*, **160**, 258 (1947).

[3] Greenough, G. B., *Proc. Roy. Soc.*, A, **197**, 556 (1949).

[4] Heyn, E., *J. Inst. Met.*, **12**, 3 (1914).

The Fundamental Relation between the Magnetic Moment and the Structure of Rotating Celestial Bodies

BLACKETT's suggestive formula[1] connecting the magnetic moment of a rotating celestial body P with its angular momentum U,

$$P = \beta \frac{G^{1/2}}{2c} U, \qquad (1)$$

where G represents the constant of gravitation, c the velocity of light and β a dimensionless quantity of order unity, has rightly aroused a great deal of criticism when it was considered to imply that every moving particle bears a virtual negative electric charge proportional to its mass.

This note is to show that we can arrive at formula (1) by very simple reasoning, by assuming that those celestial globes possess a nucleus of degenerate matter from which free electrons migrate into the outer shell more easily than the positive ions.

Let r be the radius of the core. It has acquired in the steady state a negatively charged envelope and a positively charged superficial layer, each of thickness Δ. Then the magnetic moment produced by the rotation of this charge is

$$P = \frac{16}{3} \pi \frac{\varepsilon r^3 \Delta^2 \omega}{c}, \qquad (2)$$

where ε is the density of the volume charge.

The force with which an electron is attracted by the positive sphere is

$$k = 4\pi \Delta \varepsilon e, \qquad (3)$$

and the energy required to lift the electron to the height Δ above the positive sphere is

$$k\Delta = 4\pi \Delta^2 \varepsilon e. \qquad (4)$$

Assuming this energy to be proportional to the mean kinetic energy of the particles constituting the body or proportional to the absolute temperature T_r at a distance r from the centre, we obtain:

$$4\pi \Delta^2 \varepsilon e = \varkappa R T_r, \qquad (5)$$

where R is the gas constant and $\varkappa$ is a dimensionless quantity.

We have arrived now at the relation

$$P = \frac{4}{3} \varkappa R \frac{r^3 T_r}{ec}, \qquad (6)$$

which, if I am right, is the fundamental relation for which we are looking.

The transformation of (6) into (1) is very easy. When r is a substantial fraction of r_0, the radius of the celestial body, T_r is equal to T_m, the mean temperature of this body. But[2]

$$T_m = \alpha \frac{G\mu}{R} \frac{M}{r_0} = \alpha \frac{G\mu}{R} \cdot \frac{4}{3} \pi \rho_m r_0^2, \qquad (7)$$

where M denotes the mass of the celestial body, ρ_m its mean density, μ the average mass of one molecule, and α is a dimensionless quantity of order unity depending on the internal structure of the body.

Let γ represent the ratio of r to r_0; then

$$P = \frac{10}{3} \frac{\alpha\varkappa}{\gamma^3} \frac{G\mu}{ec} U. \qquad (8)$$

With the substitution of the dimensionless quantities

$$\tau = \frac{\mu}{e} G^{1/2} \quad \text{and} \quad \beta = \frac{20}{3} \frac{\alpha\varkappa\tau}{\gamma^3}, \qquad (9) \text{ and } (10)$$

we obtain (1).

The theory can be applied equally well to two bodies which are so different as a planet and a star. Facts prove the existence of the nucleus of the earth, whereas theories of the internal constitution of the stars tend towards the acceptance of stellar cores.

Moreover, from (7) it would follow that the mean temperatures of the earth and the sun are in the ratio

$$\rho_e r_e^2 / \rho_s r_s^2, \qquad (11)$$

other variables supposed equal, where r_e and ρ_e are the radius and average density of the earth, r_s and ρ_s the radius and average density of the sun.

As ρ_e/ρ_s is roughly 4 and r_e/r_s is roughly 1/100, we obtain, when a mean temperature of 6,000° for the earth is assumed, a mean temperature of 15,000,000° for the sun, which is of the right order of magnitude.

The theory involves that the magnetic field experienced at the surface of a globe may be greatly modified by the characteristics of its shell, as is the case with the earth. It is a modification of Angenheister's theory, which was based on the surplus negative charge attached to the surface of the earth, but without its apparent quantitative defects. A quantitative verification of the present hypothesis depends on the calculation of the factor $\varkappa$, which may find its early solution in theories of thermal diffusion already developed.

H. P. Berlage

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Aug. 30.

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[1] *Nature*, 159, 658 (1947).

[2] For example, Eddington, "The Internal Constitution of the Stars".

Sudden Commencements in Geomagnetism: their Dependence on Local Time and Geomagnetic Longitude

In 1948, H. W. Newton[1] found that the diurnal frequency of occurrence of 'sudden commencements' associated with geomagnetic disturbances at Greenwich over the period 1879–1944 had a broad minimum around 8 hr., and suggested that the effect was likely to be a local one. The available data from certain other observatories appeared to support this view.

There are three main types of sudden commencements. The first, or ordinary one, is characterized by an increase in the horizontal force, H, within a few minutes, following a quiet period. In the second, the increase in H is preceded by a smaller preliminary movement in the opposite direction. The third, and less frequent, type is called the 'inverted sudden commencement', because the movement is characterized by a decrease in H.

The interesting and important fact that a world-wide phenomenon should exhibit a local-time effect suggested the necessity of analysing the data from other magnetic observatories. We give here a preliminary table and account of the results. The traces for observatories 1–4 were kindly lent by the Director of the United States Coast and Geodetic Survey for the purpose of our analysis, which was confined to the horizontal force data.

Observatory	Geomagnetic Latitude	 Longitude	Period
1. Cheltenham	50·1° N.	350 5°	1922–46
2. Tucson	40·4 N.	312·2	1910–46
3. San Juan	29·9 N.	3·2	1926–46
4. Honolulu	21·1 N.	266·5	1902–46
5. Huancayo	0·6 S.	353·8	1922–46
6. Watheroo	41·8 S.	185·6	1919–46

We find that the diurnal variation of frequency at stations 1, 2, 6 in middle latitudes shows the 8-hr. minimum found by Newton at Greenwich; but at the three stations 3, 4, 5 in low latitudes the 8-hr. minimum is apparent only for sudden commencements which are followed by large or moderate disturbances. If all the sudden commencements at these low-latitude stations are analysed, the frequency curve appears to exhibit no special feature. This is illustrated in Fig. 1, which shows the frequency curves obtained by combining the data at all seven stations, including Greenwich (Curve I), at the four middle latitude stations (Curve II), and at the three low-latitude stations (Curve III).

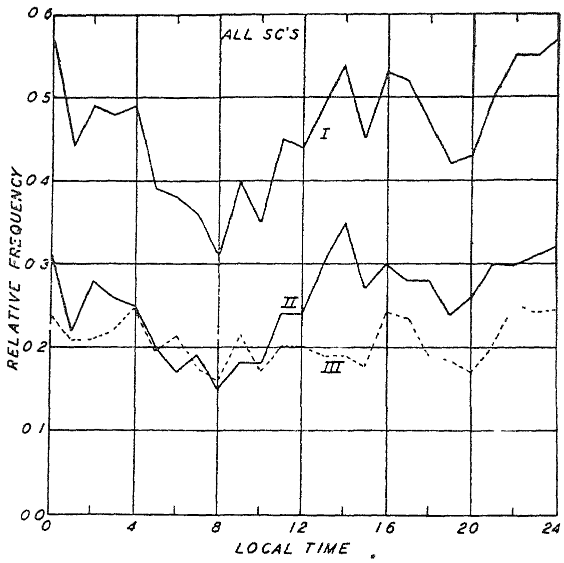

Fig. 1. Mean hourly frequency of sudden commencements. I, Combined data at all seven stations; II, combined data at Stations 1, 2, 6 and Greenwich only; III, combined data at Stations 3, 4 and 5 only

We have also formed the opinion that the frequency of occurrence of the second kind of sudden commencement depends on universal time and that, in the main, this type is more frequent in the hours following 12 hr. G.M.T. This suggests a possible dependence on geomagnetic longitude, and in Fig. 2 we have plotted the ratio of the number of second-

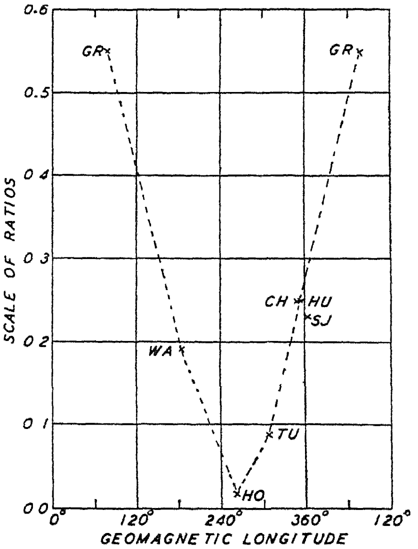

Fig. 2. Variation with geomagnetic longitude of the ratio of the number of second-type sudden commencements to all sudden commencements

type sudden commencements to the total number of sudden commencements at each of the stations 1–6 and at Greenwich. It will be seen that the points lie more or less on a smooth curve with a minimum near the longitude of Honolulu and a maximum near the longitude of Greenwich. It is also interesting to note that the values of this ratio for Cheltenham and Huancayo, which have nearly the same geomagnetic and geographic longitude, are approximately equal; also, that in the period of 46 years of records examined from Honolulu, there were only nine second-type sudden commencements. But a similar analysis at other stations, and particularly over the continent of Asia, will be needed before the suggested dependence of this type on geomagnetic longitude can be definitely established. We would urge other observatories to make such an analysis, which would help towards the understanding of these sudden movements in the earth's magnetism and the extraneous factors which are likely to influence them.

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Sept. 10.

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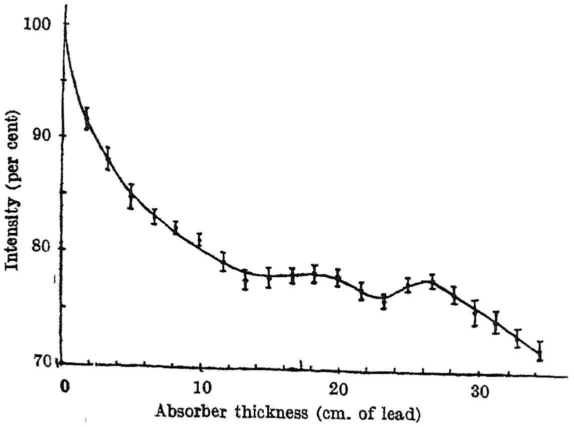
[1] *Mon. Not. Roy. Astro. Soc., Geophys. Supp.*, **5**, 159 (1948).

Anomalies of the Absorption Curve of Cosmic Rays in Lead

INVESTIGATING the absorption of the vertical component of cosmic radiation in lead by means of a Geiger–Müller counter-telescope, George and Appapillai[1] found in 1945 at sea-level (London and Colombo) that the absorption curve showed a plateau at about 10 cm. absorber thickness. Repeating the experiment in Budapest, we eliminated barometric and temperature effects (this proved to be important) by simultaneously measuring two consecutive points on the absorption curve. We found a second anomaly between 20 and 30 cm. of lead, besides that mentioned by George and Appapillai.

Using counter-telescopes of various sensitive solid angles, the effects showed up more definitely with small angles; most recently, we have used a counter-telescope with counter tubes of effective length 50 cm. and diameter 6 cm., the top and bottom tubes being 90 cm. apart. The accompanying graph shows the results obtained at barometric pressures between 750 and 760 mm. mercury. At the absorber thickness of 18·2 cm. lead, within the plateau of George and Appapillai, we observed a maximum smaller than the standard deviation; at 26·6 cm., however, the second anomaly consists of a maximum amounting to 2·5 times the standard deviation; thus we consider it to be real. At barometric pressures of more than 760 mm. mercury, this maximum shifts to smaller absorber thicknesses; at pressures lower than 750 mm. mercury, it is to be found at larger absorbing layers. Further investigations into this effect are being carried out.



It should be mentioned that Clay and co-workers[2-4] demonstrated the existence of a second and third maximum—besides that at 1·6 mm. lead—on the ionization curve at about 16 and 25 cm. lead, as well as[3-5] a second maximum between 16 and 21 cm. lead on the shower curve, both curves being plotted against the absorber thickness.

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Sept. 15.

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[1] George, E. P., and Appapillai, V., *Nature*, **155**, 726 (1945).

[2] Clay, J., *Physica*, **3**, 332 (1936).

[3] Clay, J., Gemert and Wiersma, *Physica*, **3**, 627 (1937).

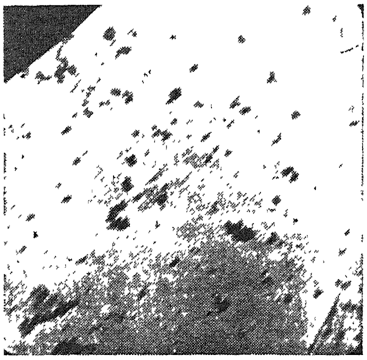
[4] Clay, J., Venema and Jonker, *Physica*, **7**, 673 (1940).

[5] Clay, J., and Scheen, *Physica*, **14** (viii) (1948).

Preparation of Colloidal Silver-Iodide Water-Suspensions for Nucleation of Supercooled Clouds

IN the course of a search for a suitable form in which particles of silver iodide can serve as nucleating agents of a supercooled cloud, Vonnegut tested[1] an aqueous solution of silver iodide (200 gm. of silver iodide and 100 gm. of ammonium iodide in a mixture of 750 c.c. of acetone and 250 c.c. of water). It is reported by him that "solutions can be diluted any desired amount with acetone; dilution with water causes precipitation of AgI". On the other hand, it was known[2] that in experiments on artificially induced rain from supercooled clouds in Algeria, a colloidal aqueous suspension (1/1,000, 1/10,000 by weight) of silver iodide was used with success. Since no particulars of this colloidal aqueous suspension were available, it was decided to try to produce a colloidal suspension (*a*) as stable as possible, (*b*) one that can be diluted to any proportion with water.

The preparation was based on well-known principles: the solubility of crystalline substances, apart from their peculiar behaviour, is a function of the size of the particles. Particles less than 1 μ have a greater solubility than larger ones; moreover, the value of S (solubility) depends upon (*a*) the excess of common ions, (*b*) the concentration of reactive components, and (*c*) the total electrolytic concentration. 0·716 gm. of potassium iodide was dissolved in 140 c.c. of water. While vigorously stirring, a solution of an equivalent amount of silver nitrate (0·734 gm.) dissolved in 80 c.c. water and 20 c.c. acetone was added drop by drop. If the stirring is sufficiently rapid, the rate of addition can be increased. This suspension was then diluted with 760 c.c. water. The silver iodide particles are protected against coagulation by the 'own-ion effect'



and, therefore, the above suspension can be diluted to 1/10,000, or 1/100,000, etc., by adding the requisite amount of water.

An examination of the particles from a 1/100,000 (by weight) suspension (see electron-photomicrograph, scale 1 : 7,000) has shown that the size of the particles is of the order of $0 \cdot 1\,\mu$ in diameter, that is, it is of the same order of magnitude as for particles obtained in the generation of smoke by vaporizing silver iodide[3].

Examination in Tiselius's kataphoresis apparatus demonstrated that the particles are negatively charged, if a solution of silver nitrate is added to the potassium solution, and positively charged if that order is reversed. Having lost their charge to the anode or the cathode respectively, the particles coagulated and fell to the bottom of the vessel. This was accompanied, as a result of action of light, by the breakdown of the molecules into silver and iodine.

The amount of silver iodide precipitated after four weeks was examined analytically and found to be between 5 and 10 per cent.

To test the usefulness of the silver iodide suspension, a domestic refrigerator was used as cold chamber, as suggested by Schaefer[4]. A supercooled cloud was produced by a wet rag, or by breathing into the chamber. A number of sprayers, producing different sizes of droplets, was used in the course of the experiments. In a number of cases the temperature near the bottom of the chamber varied between − 3° and − 20° C. In all these experiments the supercooled cloud turned into an ice-cloud 20–30 sec. after spraying. In some cases crystals were still observable 25 min. after the appearance of the first ice-cloud; but by then the temperature in the chamber rose so high (at the top above 0° C., the room temperature being 29° C.) that the ice crystals soon melted.

As expected, the sign of the charge of the silver iodide particles had no effect.

Suspensions fourteen days old have been tested for efficiency of nucleation. It was found that at a given temperature there is no visible difference between a fourteen-day old and a freshly prepared suspension. In Cwilong's experiments[5], silver iodide particles, evaporated from a platinum wire, showed noticeable ageing. The slow ageing of silver iodide in the water-suspension suggests that this suspension may be economical in use in experiments on cloud seeding, since it can be stored without deterioration for some time.

A detailed report of the results will be published elsewhere. The work was carried out under the auspices of a research committee formed by representatives of the Department of Research (Ministry of Agriculture), the Israeli Meteorological Service (Ministry of Transport and Communications) and the Weizmann Institute of Science, Rehovoth.

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Weizmann Institute of Science,
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HAVA NEUMANN
Rainfall Research Committee,
Israel.

Sept. 9.

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[1] Project Cirrus, Gen. Electric (1948), p. 88.

[2] Ducellier, G., *Agria*, **17**, 223.

[3] Project Cirrus, Gen. Electric (1948), p. 27 and p. 82.

[4] *Chem. Rev.*, **44**, 291 (1949).

[5] *Nature*, **163**, 727 (1949).

Natural Remanent Magnetism of Igneous Rocks and its Mode of Development

THE direction of remanent magnetization of igneous rocks has recently been examined in detail[1] in order to investigate the secular variation in the geomagnetic field, and its relation to the problem of the origin of the earth's magnetic field. As was pointed out by the late Prof. J. G. Koenigsberger[2], the occurrence of natural remanent magnetism of igneous rocks is due to a particular magnetic characteristic of the ferro-magnetic minerals, viewed from the physical point of view.

The natural remanent magnetization of rocks, which is fairly intense, can be reproduced only by their cooling in the geomagnetic field from a temperature higher than their Curie point. The temperature-range effective for this magnetic field cooling extends over about 200° below the Curie point, as shown in Fig. 1. The development characteristics of the remanent magnetization caused by cooling in a weak magnetic field can be shown directly by the results of the following experiments.

A rock sample having its Curie point at 585° C. is cooled, for example, from 550° to 500° C. in a weak magnetic field F, and then the magnetic field is removed, with the result that almost the whole

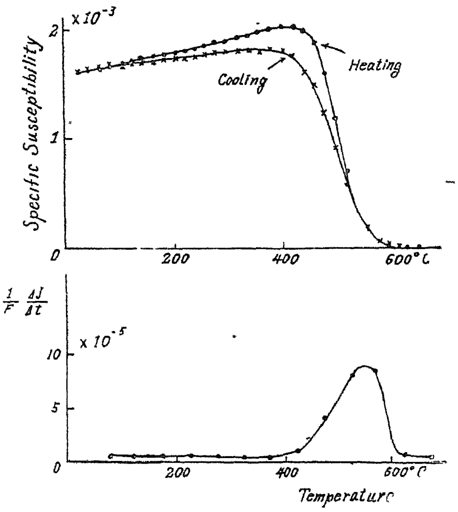

Fig. 1. Change in magnetic susceptibility with temperature (above) and the remanent magnetization produced by partial cooling in a magnetic field at various temperatures. (Sample: augite-bearing olivine-basalt)

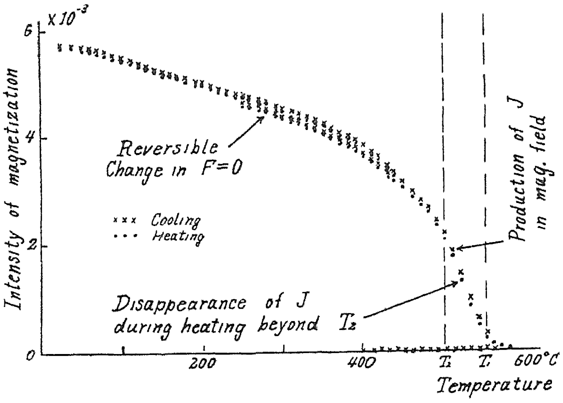

Fig. 2. Development of magnetization by cooling in magnetic field, its reversible change in non-magnetic space, and its disappearance by heating. (Sample: olivine-hypersthene-pyroxene-basaltic andesite)

of the magnetization produced persists as the remanent magnetism. Below 500° C., the remanent magnetization $J(t)$ still increases with decrease in temperature even in non-magnetic space, and $J(t)$ changes reversibly with the change in temperature t, provided that t does not exceed 500° C. and no magnetic field is further applied during any process of cooling. The results of a group of similar experiments show that the nucleus of remanent magnetization in rocks produced by cooling from T_1 to T_2 $(T_1 > T_2)$ in a field F always disappears on heating them from T_2 through T_1, regardless of the intensity and direction of magnetic field applied during the heating process.

This law holds even when $T_1 - T_2 = \Delta T = 5°$. We may say, then, that some vectors of magnetic domains in the ferro-magnetic minerals are fixed in the direction of the applied magnetic field during cooling from T_1 to T_2 in the magnetic field F, while they are released in the reverse process. The reversible change of $J(t)$ with temperature below T_2 may correspond to the reversible change in the spontaneous magnetization of domains, well known as the Curie law.

If $\varphi(F,T)$ denotes the probability of orientation of domain vectors in the direction of F during cooling through a small temperature-range ΔT around $T = (T_1 + T_2)/2$, and $I(T,t)$ gives the intensity of their spontaneous magnetization at t, we get for the magnitude of the corresponding remanent magnetization:

$$\Delta J = I(T,t).\varphi(F,T)\Delta T, \quad t < T.$$

Experiments on a number of rock samples indicate that $\varphi(F,T)$ changes with T in a manner similar to the curve shown in Fig. 1, and that values of $\Delta J(T,t)$ produced in a rock sample at different values of T are independent of each other. Then, denoting the remanent magnetization at t produced by cooling from T_1 to T_2 in the field F by $J^{T_2}_{T_1}(F,t)$, we can write:

$$J^{T_2}_{T_1}(F,t) = \int_{T_2}^{T_1} I(T,t)\varphi(F,T)dT, \quad (t < T_2 < T_1),$$

where $\varphi(F,T)$ takes place only during the cooling process and vanishes during the heating process. When F is small ($\lesssim 1$ oersted), it is found that $\varphi(\mathbf{F},T) \simeq \mathbf{F}.\psi(T)$. Thus,

$$\mathbf{J}^{T_2}_{T_1}(F,t) \simeq \mathbf{F}\int_{T_2}^{T_1} I(T,t)\psi(T)dT.$$

The other observed facts that $\varphi(F,T)$ is large in rocks of large coercive force, and that the usual A.C. demagnetizing method (up to a magnetic field 100 times F) can scarcely remove the remanent magnetization produced by cooling in a weak magnetic field, may suggest that $\varphi(F,T)$ is due to a fairly strong internal stress in the ferromagnetic minerals in rocks.

A similar phenomenon has been recently found in the magnetic properties of $CoO.Fe_2O_3–Fe_3O_4$, and those of $TiO_2Fe_2O_3–Fe_3O_4$ are now being examined.

My thanks are due to Mr. H. Manley for a useful discussion.

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Tokyo.
Sept. 8.

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[1] Bruckshaw, E. McG., and Robertson, E. I., *Mon. Not. Roy. Astro Soc., Geophys. Supp.*, **5**, 308 (1949). Chapman, S., *Nature*, **161**, 462 (1948).

[2] Koenigsberger, J. G., *Terr. Mag.*, **43**, 119 and 299 (1938), and elsewhere.

Partial Ionization in Lithium Hydride

SINGLE-CRYSTAL rotation photographs of lithium hydride (LiH), using copper $K\alpha$ radiation, show clearly that the structure is of a sodium chloride type, but that the lithium and hydrogen atoms are by no means completely ionized. Atomic scattering curves have been drawn from the corrected intensity data for the 'all even' reflexions (Li + H); and for the 'all odd' reflexions (Li − H). From these the separate atomic scattering curves for the Li^{+x} ion and for the H^{-x} ion (uncorrected for temperature scattering) have been deduced. The thermal scattering, which is of the same order as that in sodium chloride (though differently distributed), has also been studied separately by means of 'diffuse' Laue photographs. The results show that the most probable state of ionization is $Li^{+0\cdot25}$, $H^{-0\cdot25}$. The absolute limits that could be supposed to agree with the observations would be 50 per cent ionic character or, at the opposite extreme, complete covalency.

I am indebted to Prof. Kathleen Lonsdale for help and advice in this research, which will be published more fully later.

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London.
Nov. 11.

Action of Phenolic Substances on the Blood-clotting Effect of *Bothrops atrox* Venom

Gerber and Blanchard[1] reported the accelerating effect of different phenols on blood clotting. Laki *et al.*[2] have also found that catechol added to thrombin shortens the coagulation time of plasma.

During a series of experiments which were carried out for the purpose of comparing the blood-clotting effect of *Bothrops atrox* venom and thrombin, the action of certain phenolic substances on the coagulation has also been investigated. The differences between the two coagulating principles have been

CLOTTING TIMES OF PLASMA AND FIBRINOGEN IN SECONDS IN PRESENCE OF DIFFERENT PHENOLIC SUBSTANCES OR SALINE

Added substance		Phenol		o-Cresol		Resorcinol		Catechol		Saline
Final concentration in the test in %		0·25	0·50	0 25	0·50	0 25	0·50	0 25	0·50	
Thrombin	Plasma	32	18	21	18	23	15	36	17	78
	Fibrinogen	67	45	—	—	53	40	78	50	143
Venom	Plasma	63	44	45	44	40	31	47	35	106
	Fibrinogen	80	46	—	—	54	37	67	45	160

reported elsewhere[3,4]. In the present work it is found that phenolic substances have the same effect on the two clotting agents.

In the experimental work, solutions of phenolic substances were used in such dilution that their final concentration was 0·25–0 5 per cent. Their action was tested on oxalated horse plasma and fibrinogen, which were buffered with phosphate to 6 8 *p*H. The clotting times were compared with the time obtained when. instead of the phenolic substance, physiological saline was used. The results (see table) show that the phenolic substances accelerate the clotting of plasma fibrinogen when either thrombin or *Bothrops atrox* venom are used as a clotting agent.

As an explanation of the potentiation of the thrombin fibrinogen interaction by phenols[1], the view has been put forward that blood clotting is an oxidation-reduction process which can only operate through the oxidation of susceptible SH-groups of fibrinogen by thrombin, and that this oxidation can be accelerated by the reversible oxidation-reduction of active phenols, taking the role of hydrogen carriers. Other workers[5] have denied the presence of susceptible SH-groups in fibrinogen, claiming that fibrinogen clotted normally after treatment with oxidizing agents strong enough to oxidize the sulphhydryl groups. Even though Laki and Mihályi[6] offer new possibilities for the explanation of the thrombin–fibrinogen interaction, no final explanation can yet be given of the fact that the phenolic substances do accelerate the coagulation induced by thrombin as well as by *Bothrops atrox* venom. A detailed account of the experiments above will appear elsewhere.

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Sept. 1.

[1] Gerber, C. F., and Blanchard, E. W., *Amer. J. Physiol.*, **144**, 447 (1945).

[2] Laki, K. (unpublished data).

[3] Jánszky, B., *Science* (in the press).

[4] Jánszky, B., *An. Inst. Pinheiros*, **12**, 113 (1949).

[5] Bagdy, Guba, Loránd and Mihályi, *Hung. Acta Physiol.*, **1**, 197 (1948).

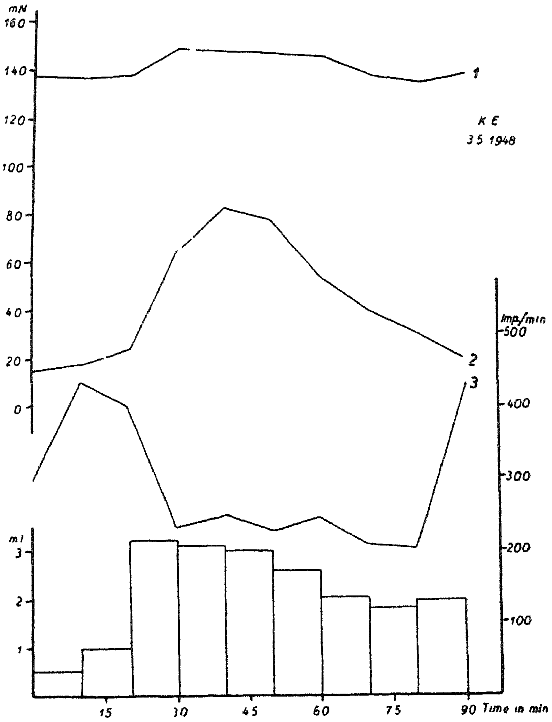
[6] Laki, K., and Mihályi, E., *Nature*, **163**, 66 (1949).

Anion Excretion by the Gastric Mucosa

CHLORIDE, bromide, iodide and thiocyanate ions have physicochemically and pharmacologically different properties. They also show different behaviour in diffusion, in affecting various tissues, in excretion by urine, in passage to the lymph, etc. These four ions have an important common quality: all have the same negative charge. In plasma, bromide, iodide and thiocyanate can replace chloride. If, for example, we increase the bromide concentration in plasma, there will, as has been shown by many investigators, be a change in the ratio bromide/chloride, but the total halide concentration remains constant.

Davenport[1,2] has examined the relations bromide/chloride and iodide/chloride in plasma and in gastric juice; he states that bromide and iodide can replace chloride in plasma and also in gastric juice. We have not laid particular stress upon the relation between the plasma content of bromides, iodides and thiocyanates, and the gastric concentrations of these ions. We examined instead the relative concentrations of the ions as contributing to the variations in the acidity of the gastric juice[3].

The excretion of bromide was studied by means of radiobromine in cats and patients. The accompanying figure shows the excretion of radiobromide in a patient after injection of histamine. The excretion of iodide in dogs and patients was studied separately by Lagergréen[4]. Thiocyanate is excreted spontaneously; but we know already from Pavlov's investigation on thiocyanate that this anion is a normal constituent of the gastric juice. Iodide was given orally the day before the experiment.



Curve 1. Total chloride content (millinormality).
Curve 2. Total acidity (millinormality).
Curve 3. Radioactivity measured in 1 ml. gastric juice.
Below, the volumes of the single fractions of gastric juice, given in ml.
Radiobromine, in a physiological salt solution, was administered intravenously (700,000 counts/min.) 2 hr. before the injection of histamine

From these investigations we have reached the following conclusions. (1) The proportion of bromide, iodide and thiocyanate in the gastric juice is higher than that in the plasma. (2) The relative concentration of these three anions in the gastric juice diminishes when the rate of secretion and the acidity increase. At the end of the effect of the histamine, the concentration of the above-mentioned ions increases simultaneously with decreasing acidity. (3) These anions replace chloride, but only neutral chloride occurring in the gastric juice. Thus, if the bromide or iodide concentration in the blood increases, the total halide concentration remains unchanged in the gastric juice. The excretion mechanism of these ions is probably the same as that of neutral chloride.

A detailed report on the different investigations on these ions and the mutual relation between the ions will be published later. This work was carried out with the aid of a grant from Wallenbergs Foundation.

ELEMÉR GABRIELI

Sahlgren's Hospital,
Surgical Service II
and Medical Service I,
Göteborg.
Sept. 15.

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[1] Davenport, H. W., and Fisher, R. B., *Amer. J. Physiol.*, **131**, 165 (1940).

[2] Davenport, H. W., *Gastroenterology*, **1**, 1055 (1943).

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Lysis by Complement of Erythrocytes which have adsorbed a Bacterial Component and its Antibody

POLYSACCHARIDE components of many pathogenic bacteria are adsorbed from solution to erythrocytes, which then become agglutinable by sera containing antibody for the appropriate polysaccharide. A protein constituent of *Hœmophilus pertussis*, and some closely related bacteria, itself agglutinates erythrocytes which have adsorbed it[1].

It has now been observed that erythrocytes which have first adsorbed a polysaccharide or protein constituent of bacteria, and then the corresponding antibody, are lysed by complement. The mechanism involved is presumably similar to that of bacteriolysis. The phenomenon is well adapted to quantitative measurements of a bacterial antibody, because of the ease with which hæmolysis can be observed and measured, and because a known component of the bacterial cell is used in the system.

Middlebrook and Dubos[2] have shown that the presence of antibody for *M. tuberculosis* is indicated by the ability of a serum to agglutinate erythrocytes coated with a polysaccharide fraction of the organism. During the examination of a number of bovine sera by this technique, anomalous results were encountered, at variance with those anticipated from tuberculin sensitivity tests, and autopsy findings. However, when complement was added to the mixtures of sera and sensitized cells, hæmolysis occurred in those tubes in which sera of tuberculous or vaccinated cattle were present, but not in those containing the sera of unvaccinated normal animals, irrespective of the prior presence or absence of hæmagglutination.

Assay of neutralizing antibody for pertussis hæmagglutinin is complicated by the fact that samples of serum vary in their content of a nonspecific neutralizing substance, which is probably identical with the lipid receptor for pertussis hæmagglutinin of the erythrocyte surface[3,4]. If, however, antibody for pertussis hæmagglutinin is assayed in terms of its capacity to sensitize to lysis by complement erythrocytes which have first been coated with hæmagglutinin, this complication is avoided.

Most varieties of erythrocytes in common use in the laboratory are susceptible to lysis by this mechanism; sheep cells are sensitive and suitable. Sheep cell lysins must first be removed from the sera under test, and from the guinea pig serum used as a source of complement.

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E. V. KEOGH

Commonwealth Serum Laboratories,
Melbourne, N.2,
Victoria.

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[1] Keogh, E. V., North, E. A., and Warburton, M. F., *Nature*, **160**, [illegible] (1947); **161**, 687 (1948).

[2] Middlebrook, G., and Dubos, R. J., *J. Exper. Med*, **88**, 521 (1948).

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'Whiptail' in Cauliflower

SINCE 1939, several workers[1,2] have shown that molybdenum is an essential element for crop plants, and in 1945 it was suggested by Davies[3] in New Zealand that a deficiency of this element was responsible for the condition in brassicas known as 'whiptail'.

'Whiptail' of cauliflowers and broccoli, characterized by severe restriction of the leaf lamina, death of the growing point and chlorosis, is endemic in south-eastern England, more especially on soils derived from the Hastings Beds, and occasionally severe losses are experienced. The trouble appears to be worst in dry seasons, and usually but not invariably occurs on acid or slightly acid soils; in such cases a dressing of lime often effects a partial or complete cure.

Following chemical evidence obtained in 1947 that 'whiptail' might be caused by low molybdenum status, field-trials were laid down in 1948 and 1949 to test the effects of a molybdenum salt and of lime on this disease. The 1948 trial proved unsuccessful due to the non-appearance of the trouble. The 1949 trial was carried out on a slightly acid (*p*H 6·0) soil derived from the Tunbridge Wells Sandstone and on a field where 'whiptail' had caused considerable losses in past years. Four replicated treatments were given, and the details of these treatments as well as the percentages of affected plants when the crop was nearing maturity are as follow:

1.	Control	69 per cent affected with 'Whiptail'
2.	Ground chalk at 2 tons per acre	31 ,, ,, ,, ,,
3.	Chalk plus sodium molybdate at 10 lb. per acre	12 ,, ,, ,, ,,
4.	Sodium molybdate at 10 lb. per acre	18 ,, ,, ,, ,,

In this trial, therefore, it will be seen that liming has effected some improvement, while sodium molybdate has markedly reduced the percentage of affected plants.

Observations made during the course of these investigations, however, may suggest that in certain cases 'whiptail' may be due to cultural causes rather than to molybdenum deficiency.

Confirmatory evidence has also been obtained for the recent suggestion by Nicholas[4] that there is a strong inter-relationship between manganese and molybdenum in cases of 'whiptail'.

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W. DERMOTT

Ministry of Agriculture and Fisheries
National Agricultural Advisory Service,
Wye, Ashford, Kent.
Sept. 26.

[1] Arnon, D. I., and Stout, P. R., *Plant Physiol.*, **14**, 599 (1939).

[2] Piper, C. S., *J. Aust. Inst. Agric. Sci.*, **6**, 162 (1940).

[3] Davies, E. B., *Nature*, **156**, 392 (1945).

[4] Hewitt, E. J., Jones, E. W., and Nicholas, D. J. D., Ann Rep Long Ashton Res. Stn., 79 (1947).

Aeration of Culture Media

IN biological work, oxygen has often to be supplied to an organism by bubbling air, or some other oxygen-containing gas, through the culture medium. The rate at which oxygen is available for consumption by the organism is frequently limited by the rate at which oxygen dissolves from the gas phase. Although this has been realized[1], there has been little attention given to this point in the literature. An easy method of assessing the effect of aeration has been developed, using a polarograph to measure the concentration of dissolved oxygen[2].

It is well known[3] that the rate of solution of oxygen in a liquid can be expressed by an equation:

$$\frac{dC}{dt} = \varphi_L\,(C_e - C), \qquad (1)$$

where φ_L is a constant with respect to C and t, C is the concentration of dissolved oxygen at time t, and C_e is the concentration of dissolved oxygen when the solution is saturated with oxygen at a given partial pressure of oxygen in the gas phase. From equation (1) the maximum rate at which oxygen dissolves is given by $\varphi_L C_e$. The value of $\varphi_L C_e$ can be determined in two ways:

(i) The vessel is filled with a solution of potassium chloride or a fermented medium with the oxygen demand inhibited. The dissolved oxygen is then removed by gassing out with nitrogen. Aeration is started at a given time, and thereafter samples are removed at known times and the concentration of dissolved oxygen determined polarographically. The value of $\varphi_L C_e$ can be obtained from these results by using the integrated form of equation (1).

(ii) In an aerated medium containing an organism with a zero-order oxygen demand, k_0, the concentration of dissolved oxygen will be maintained at a steady concentration C_s if $\varphi_L C_e > k_0$. It is easily shown that

$$\varphi_L = \frac{k_0}{C_e - C_s}. \qquad (2)$$

C_s is obtained by placing a sample from the fermentation vessel in the polarographic cell and measuring the concentration of dissolved oxygen against time. The plot of this is linear, with a slope k_0. It is extrapolated to the time when the sample was taken, to give the value of C_s. C_e is obtained by saturating the sample with air in the polarographic cell, and if necessary another determination of k_0 can then be made.

Values of $\varphi_L C_e$ have been determined for a number of vessels, with more than a thousand-fold variation in capacity, in which penicillin and streptomycin fermentations have been carried out. It was found that φ_L depended on the size and shape of the vessel, but was directly proportional to the rate of air-flow. φ_L was greatly increased by stirring. It was also found that when $\varphi_L C_e$ was greater than the peak oxygen demand of an adequately aerated fermentation, the titre of antibiotic produced became independent of $\varphi_L C_e$. Below this limiting value of $\varphi_L C_e$, the titre fell off quickly and reached zero at a value of $\varphi_L C_e$ approximately equal to $k_0/2$. No effect of stirring was found, apart from the increase in φ_L.

A full account of this work will be published elsewhere. I am indebted to the directors of the Distillers Company, Ltd., for permission to publish this work.

W. S. WISE

Distillers Company, Ltd.,
Great Burgh,
Epsom.
Sept. 6.

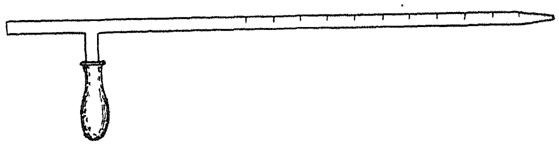
[1] Olson and Johnson, *J. Bact.*, **57**, 235 (1949).

[2] Petering and Daniels, *J. Amer. Chem. Soc.*, **60**, 2796 (1938).

[3] Sherwood, T. K., "Absorption and Extraction", 64 (McGraw-Hill, 1937).

A New Type of Pipette for Radioactive Solutions

ORDINARY pipettes cannot be used for measuring volumes of radioactive solutions, since it is highly dangerous to get a radioactive substance in the mouth. Many different pipettes have been designed to overcome this sort of difficulty[1]; but the type of pipette described below possesses advantages over existing types in simplicity of construction and ease of operation.



A side-arm about one inch long is sealed on an ordinary 1-ml. calibrated pipette, and a small rubber bulb is placed on the side-arm. With the finger on the top, the bulb can be used to draw liquid into the pipette, which can then be used in the ordinary way. For larger capacity pipettes (say, 10 ml.) it is still possible to use a small bulb, since when liquid has been drawn into the pipette the finger can be released and the bulb pressed, whereupon more liquid can be drawn up by replacing the finger and releasing the bulb. This operation can be carried out quickly enough for only a small amount of liquid to run out of the pipette.

This type of pipette has been found useful for radioactive solutions, and may find application for other poisonous or unpleasant liquids.

A. J. SWALLOW

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University,
Edgbaston, Birmingham 15.
Nov. 1.

[1] Rheinfels, *Chem. Tech.*, **16**, 146 (1943).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, February 13

Royal Geographical Society (at 1 Kensington Gore, London, S.W.7), at 5 p.m.—Mr. J. M. Hartog: "Oxford Expedition to the Arctic".

Institution of Electrical Engineers (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Interference Suppression" (to be opened by Mr. E. M. Lee).

Institution of the Rubber Industry, Midland Branch (at the James Watt Institute, Great Charles Street, Birmingham), at 7 p.m.—Mr. J. M. Buist: "Abrasion Resistance and its Measurement".

University of London (at the Institute of Archæology, Inner Circle, Regent's Park, London, N.W.1), at 8 p.m.—Dr. W. F. Libby: "The Carbon-14 Method of Dating".

Tuesday, February 14

Royal Anthropological Institute (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Dr. Philip Mayer: "Privileged Obstruction of Marriage Rites among the Gusii".

Zoological Society of London (at the Zoological Gardens, Regent's Park, London, N.W.8), at 5 p.m.—Scientific Papers.

Institution of Chemical Engineers (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Conference on "Formation and Properties of Gas Bubbles".

University of London (at King's College, Strand, London, W.C.2), at 5.30 p.m.—Mr. W. P. Mansfield: "Equipment and Experimental Methods used in the Study of Internal Combustion Engines".*

Manchester Geographical Society (at the Geographical Hall, 16 St. Mary's Parsonage, Manchester), at 6.30 p.m.—Prof. David L. Linton: "Landform Studies in the Cairngorm Mountains".

Society of Chemical Industry, Plastics and Polymer Group (at the Royal Society of Tropical Medicine, Manson House, 26 Portland Place, London, W.1), at 6.30 p.m.—Dr. K. W. Pepper: "Recent Developments in Ion-Exchange Resins".

Institution of Works Managers, Leicester Branch (at the College of Technology, The Newarke, Leicester), at 7 p.m.—Mr. J. W. Hendry: "Time Study as an Aid to Productivity".

Sheffield Metallurgical Association (at 198 West Street, Sheffield), at 7 p.m.—Dr. N. J. Petch: "Griffith Cracks".

Royal Statistical Society, Tees-side Sub-Group of the Industrial Applications Section (at the William Norton School, Norton), at 7.15 p.m.—Mr. L. T. Wilkins: "Man-Machine Relationships (Some Studies in Flying Safety)". (To be repeated at 6.30 p.m. at the Chemical Industries Club, 18 Lovain Place, Newcastle-upon-Tyne, on Wednesday, February 15.)

Wednesday, February 15

Physical Society, Colour Group (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 2.30 p.m.—General Discussion on "Colour Systems" (to be opened by Mr. R. G. Horner).

University of London (in the Wright-Fleming Institute Theatre, St. Mary's Hospital Medical School, London, W.2), at 5 p.m.—Prof. Z. M. Bacq (Liège): "The Metabolism of Adrenaline" (Belgian Interchange Lecture).*

Institution of Electrical Engineers, Radio Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. G. Millington and Mr. G. A. Isted: "Ground-Wave Propagation over an Inhomogeneous Smooth Earth—Experimental Evidence and Practical Implications".

Royal Microscopical Society (in the Hastings Hall, B.M.A. House, Tavistock Square, London, W.C.1), at 5.30 p.m.—Scientific Papers.

Royal Institute of Chemistry, Newcastle and North-East Coast Section (in the Chemistry Building, King's College, Newcastle-upon-Tyne), at 6.30 p.m.—Prof. T. P. Hilditch, F.R.S.: "The Constitution of Drying Oil Glycerides".

Institution of Electrical Engineers, Maidstone District (at the New Inn, Sandling Road, Maidstone), at 7.30 p.m.—Mr. J. T. Hazel: "An Historical Survey of the Development of Electric Cables".

Society of Instrument Technology, North-West Section (in the Reynolds Hall, College of Technology, Manchester), at 7.30 p.m.—Mr. J. Blears: "The Mass Spectrometer".

Thursday, February 16

University of London (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Prof. J. B. S. Haldane, F.R.S.: "The Use and Abuse of Statistics".*

Royal Society (at Burlington House, Piccadilly, London, W.1), at 2.15 p.m.—Discussion on "The Mode of Action of Local Hormones" (to be opened by Prof. J. H. Burns, F.R.S.).

Institution of Mining and Metallurgy (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. P. F. Holt: "The Determination of the Mass Concentration of Air-borne Dusts—an Apparatus for the Sublimation of Volatile Filter Bases"; Dr. J. S. Webb and Mr. A. P. Millman: "Heavy Metals in Natural Waters as a Guide to Ore—a Preliminary Investigation in West Africa"; Mr. G. F. Mortimer: "Grade Control".

London Mathematical Society (at University College, Gower Street, London, W.C.1), at 5 p.m.—Prof. B. L. van der Waerden: "Birational Invariants".

Physical Society, Acoustics Group (in the Small Physics Lecture Room, Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 5 p.m.—Mr. R. S. Dadson: "Determination of the Threshold of Hearing".

Chemical Society (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 7.15 p.m.—Prof. J. W. Cook, F.R.S.: "Polycyclic Aromatic Hydrocarbons" (Pedler Lecture). (To be repeated on Thursday, March 9, in the Chemistry Department, The University, Manchester, at 6.30 p.m.)

Chemical Society, Aberdeen Section (joint meeting with the Royal Institute of Chemistry and the Society of Chemical Industry, in the Chemistry Department, Marischal College, Aberdeen), at 7.30 p.m.—Dr. James Taylor: "Applications of Exothermic Solid Reactions to Jet Propulsion and Industrial Purposes".

Royal Society of Tropical Medicine and Hygiene (at Manson House, 26 Portland Place, London, W.1), at 7.30 p.m.—Dr. Joseph E. Smadel (Washington, D.C.): "Chloramphenicol (Chloromycetin) and Tropical Medicine".

Friday, February 17

Eugenics Society (at Manson House, 26 Portland Place, London, W.1), at 5 p.m.—Dr. A. S. Parkes, F.R.S.: "The Primrose Path, some Aspects of the Population Problem" (Galton Lecture).

University of London (in the Wright-Fleming Institute Theatre, St. Mary's Hospital Medical School, Paddington, London, W.2), at 5 p.m.—Prof. Z. M. Bacq: "The Potentiation of Biological Responses by Potassium Ions" (Belgian Interchange Lecture).*

Institute of Physics, Manchester and District Branch (in the New Physics Theatre, The University, Manchester), at 7 p.m.—Dr. F. A. Vick: "Musical Acoustics".

Saturday, February 18

Manchester Literary and Philosophical Society, Social Philosophy Section (at Holly Royde, 30 Palatine Road, Withington, Manchester), at 2.45 p.m.—Mr. A. K. Cairncross: "Some Problems of Planning".

Institution of Office Managers, Sheffield Branch (joint meeting with Local Studies Group, at the Royal Victoria Station Hotel, Sheffield), at 3 p.m.—Mr. J. C. W. Stead: "Education for Management".

British Psychological Society, Social Psychology Section (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 8 p.m.—Dr. J. C. Flugel: "Tolerance" (Chairman's Address).

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant Lecturers in the Department of Chemistry—The Secretary, Queen's University, Belfast (February 20).

Examiners in Chemistry and Physics, Biology (Botany and Zoology), Physiology (including Biochemistry) of the Domesticated Animal, Histology and Embryology, Animal Management, Anatomy of the Domesticated Animals, Pharmacology, Matéria Medica and Pharmacy, Veterinary Hygiene, Dietetics and Animal Husbandry, Veterinary Pathology, Veterinary Parasitology, Veterinary Medicine, Veterinary Surgery—The Registrar, Royal College of Veterinary Surgeons, 9 Red Lion Square, London, W.C.1 (February 20).

Registrar and Secretary—The Chairman, Professional Engineers Appointments Bureau, 9 Victoria Street, London, S.W.1 (February 20).

Resident Lecturer (woman) in Physiology, Anatomy, Pathology or Biochemistry—The Principal, Newnham College, Cambridge (February 28).

Cow and Gate Fellowship for research into problems associated with nutrition in infants and children—The Registrar, The University, Manchester 13 (March 3).

Head of the Chemistry Department, a Head of the Civil and Mechanical Engineering Department, and a Head of the Physics Department—The Clerk to Governing Body, Battersea Polytechnic, Battersea, London, S.W.11 (March 3).

Lecturer in Agricultural Chemistry—The Secretary and Registrar, University College of North Wales, Bangor (March 4).

Research Officer (Ref. No. 2346) in the Division of Industrial Chemistry, Melbourne, to carry out investigations on the application of mass spectroscopy to physico-chemical problems, and a Research Officer (Ref. No. 2584) in the Building Research Laboratory, Melbourne, to develop equipment for measuring stress and strain and to apply these to problems of stress analysis associated with building materials and structures—The Chief Scientific Liaison Officer, Australian Scientific Research Liaison Office, Africa House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (March 4).

Senior Physicist at the Cancer Institute, Melbourne—The Manager and Secretary, Cancer Institute Board, 483 Little Collins Street, Melbourne, Victoria, Australia (April 6).

Chair of Physics, and the Macarthy Chair of Economics, at the Victoria University College, Wellington, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (May 31).

Chair of Pure Mathematics—The Registrar, The University, Nottingham.

Junior Physical Chemist in the Chester Beatty Research Institute, to work on proteins (by electrophoresis and diffusion methods, etc.)—The House Governor and Secretary, Royal Cancer Hospital, Fulham Road, London, S.W.3.

Lecturer in Metallurgy—The Registrar, Central Technical College, Suffolk Street, Birmingham 1.

Senior Crop Recorder, a Crop Recorder, and a Junior Assistant for Potato Investigations—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

Studentships for postgraduate training in Plant Breeding, Plant Physiology, and Entomology—The Secretary, Empire Cotton Growing Corporation, 12 Chantrey House, Eccleston Street, London, S.W.1.

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CO-OPERATION IN COLONIAL DEVELOPMENT

As has already been noted in *Nature*, the Parliamentary and Scientific Committee has been closely considering the implications of President Truman's 'fourth point' regarding technical assistance to the backward areas since it was first made known in his inaugural address in January 1949. Following the circulation of all available information, a sub-committee was appointed, and the interim report of this committee (see *Nature*, 164, 463; 1949) was sent to appropriate Ministers on July 29, 1949. Afterwards, Mr. M. P. Price, chairman of the Parliamentary and Scientific Committee, attended the World Resources Conference at Lake Success; and at a meeting of the Committee on November 8, Mr. Price, and also Dr. W. F. P. McLintock, director of the Geological Survey and Museum, Mr. Michael Graham, director of fishery research, and Prof. W. N. Woodward, director of the Scottish Seaweed Research Association, all of whom had attended the Conference, spoke of the work of the Conference particularly with a view to possible further useful action by the Committee.

In Dr. McLintock's view, Great Britain is fulfilling its obligations to the under-developed countries to the limit of its man-power; and confirmation of this can well be found in the statement recently published by the Colonial Office. The recruitment of more than fourteen hundred highly qualified men and women last year for the Colonial Service represents no mean tax on the trained man-power of the country. It approaches ten per cent of the present annual output of university graduates, and with 1,130 vacancies still to be filled, three-quarters of which are in East, West and Central Africa, the situation cannot be viewed with any complacency. Moreover, quite apart from the Colonial Service and the situation revealed by the last report on Colonial research, to which special attention has already been directed in these columns (*Nature*, 164, 461; 1949)—the recent report of the Overseas Food Corporation and the African Regional Scientific Conference at Johannesburg (cf. *Nature*, 164, 901; 1949) have stressed the great need for scientific workers to assist in dealing with African problems. The recent announcement that a technical survey of the Volta River, the largest in the Gold Coast, with a view to the development of its resources for irrigation, navigation and hydro-electric power, is being made at the request of the Gold Coast Government, by a panel of five engineers from a private firm of consulting engineers, shows that other reserves of scientific and technical skill are already being called upon to make good the deficit of government officers which, as the Johannesburg Conference indicated, is felt acutely in every territory and almost every field of science. Moreover, while the second report of the Inter-University Council for Higher Education in the Colonies shows that the Colonial universities are making real progress towards meeting such needs—the Faculty of Rural Sciences established at University College, Ibadan, to give teaching agriculture, veterinary science and, later, forestry deserves particular mention—it is clear from the same report that for some years to come they will draw heavily on the universities of Great Britain.

One of the most impressive features both of the World Resources Conference and of the African Regional Scientific Conference was the clear recognition of the need for co-operation across regional boundaries, and across the divisions of science itself. Sir Harold Hartley, leader of the British delegation at Lake Success, in his summing-up speech on the final day, stressed the need for a synthesis of specialists, so that water-power, irrigation, soil fertility, animal and plant husbandry could be developed together in a balanced system. In recommending the establishment in a consultative and advisory capacity of a scientific council for Africa south of the Sahara, the Johannesburg Conference also gave expression to its recognition of the need for pooling our knowledge and organising a broader collaborative approach not only to research problems but also to scientific and technical matters generally.

The Parliamentary and Scientific Committee has from the first considered President Truman's 'fourth point' primarily to ascertain how British resources in science and technology could collaborate most fully, and also how American technology and capital could further the plans we have already formulated for improving the conditions of the under-developed areas in British Colonial territory. It is encouraging to note that the panel of engineers surveying the Volta River has been instructed to take full account of the best methods for the economic development of the resources available, including not only hydro-electric power but also the irrigation and drainage of lands in or near the catchment area, the provision of port facilities, the possible improvement of transport by developing a system of navigation on the lake which would be formed by the proposed dam or by any other means. The distribution of the power between aluminium production and other industries and the towns, and the effect of development on native systems of land tenure and water rights, are also to be the subject of examination and recommendation.

Clearly the scarcity of properly trained scientific observers puts a limit to such surveys, fundamentally because their work is the necessary basis for sound planning. Even on the smaller scale, such matters as the re-settlement and improvement of African lands may be hindered by the lack of trained staff, as much as by lack of agricultural machinery. These are the chief factors that have hampered the Government of Kenya, for example, in its schemes for enlisting African co-operation not only in re-settlement but also in the restoration of fertility to the soil and the improvement of cultivation. More than £300,000 has been spent for this purpose since 1946, and between fifty and sixty projects are in progress or envisaged under the Kenya Development Plan.

The solid achievements of the Kenya Government in this field are now having their effect in making it easier to secure the co-operation of the Africans themselves, and the importance of this further limiting factor on the rate of progress needs to be kept in mind. Dr. Alexander King, in addressing the Parliamentary and Scientific Committee, referred to the great danger of forcing rapid developments without sufficient understanding of conditions and human resources. In his view, one of the most valuable features of the World Resources Conference was the way in which the general recognition that the future of the backward areas really depends on a co-ordinated policy of land conservation, water conservation, mineral development, agriculture and even education, has left on the minds not merely of those from the under-developed areas, but also of other countries, such as the United States, a salutary impression of the complexity of the whole question of development. Moreover, on the political level, Dr. King thought that the high quality of the United Kingdom representatives had given a most convincing demonstration of the immense amount of scientific experience which Great Britain has already gained in this field.

The importance of any such demonstration at the present time is not easily exaggerated. Even in the United States, ignorance of British achievements in the Colonial field is still widespread, and failure to understand the difference between the Colonial territories and the Dominions is common. Although such technical conferences as those at Lake Success and Johannesburg can only go a limited way in dispelling such misconceptions and misunderstandings, they at least provide a firm basis for the wider effort at popular education which is an essential condition for the mutual understanding and appreciation on which co-operative effort to assist the peoples of the under-developed areas must be based.

Nor is it only the British Colonial effort that is often not understood or even misrepresented; it is equally true of the French, the Dutch and the Belgian efforts. Little is popularly known, for example, of the important Belgian plans for developing the Congo during the next ten years, or of what has already been done in that area, which is still in an early stage of its development. Development of the Congo region is conditioned partly by the character of the country and partly by the distribution of the mineral resources; but through the area runs the strategic traffic artery which links the Atlantic with the upper waters of the Nile, and the first main motor highway between the Mediterranean and the Cape. So Belgium can with equanimity allow Congo communications to be integrated with the trans-African traffic routes.

Communications, electricity and agricultural development account for most of the estimated £285,000,000 of the ten-year plan; but even if Belgium is able to find the funds and requires no assistance under the United Nations plan for technical assistance to backward areas, the importance of international goodwill and understanding for the realization of its full effects needs scarcely to be stressed. That, however, is exactly what is endangered by recent proceedings under the Trusteeship Council and the Assembly of the United Nations. Lord Tweedsmuir spoke well and forcefully on this point in the debate on Colonial administration in the House of Lords on November 30 in deploring the failure of the

Trusteeship Council to move with us from the fatherly conception of trusteeship to the more brotherly conception of partnership. Lord Listowel, replying for the Government during the debate, made it very clear, as Lord Tweedsmuir wished, that, while advice or constructive criticism would be welcomed, Great Britain continues to accept full responsibility to the Colonial peoples.

Lord Listowel dealt in particular with the Trusteeship Council's decision to ask the Assembly to request Colonial Powers to add, to the subjects about which it has already been agreed to give information, the political and constitutional development of their Colonies, and to appoint a committee which will sit for three years, with powers of roving inquiry into social conditions and educational practice in Colonial territories. Lord Listowel rightly insisted that what mattered is the spirit in which the criticism is made and the motives of the critics themselves. Further, the criticism received from the United Nations, he said, is often characterized by an absence of realism and a failure to put forward practical suggestions, which results naturally from the inexperience of non-administering Powers, quite apart from the constant failure to distinguish between supervision of trust territories and interference in administration all along the line.

Lord Tweedsmuir made an interesting point when he observed that the Colonial territories had self-government before Great Britain went there; but what they are now asking for is a peculiarly British invention, namely, responsible government. The prerequisite of responsible government is the availability of men and women capable of discharging the duties involved. The full reply to the Trusteeship Council is, of course, an even more energetic attack on the problem of education, both in the backward areas and also in the world at large, so as to create an informed world opinion on Colonial affairs and on the position and possibilities in the backward areas.

Such an informed world opinion is, in fact, no less desirable in regard to the United Nations Organisation's own plans for technical assistance for economic development of the backward areas. These plans involve the expenditure of 35·9 million dollars in the first year and 50·2 million dollars in the second year on expert missions to the undeveloped countries, training students, financing scientific and industrial research, supplying seed, medical and technical equipment and in other ways spreading a knowledge of modern technique throughout these areas. These plans are at present tentative and tenuous, as well as extremely varied, and considerable possibilities of duplication exist, especially in the absence of any generally agreed definition of economic development method for developing areas. Moreover, for reasons explained by the Secretary-General in issuing the United Nations plan for Technical Assistance for Economic Development last April, it is not possible to prepare a combined budget covering both the United Nations and the 'specialized agencies'; and the effective spending of the budgeted 85 million dollars in two years is improbable because of the absence of competent experts in the numbers required.

Both these points, the importance of effective co-operation and of the limiting factor of the numbers of trained men and women available, were well brought out by other speakers also in the House of Lords debate already noted. Lord Tweedsmuir had urged that the fundamental step in Colonial welfare is education of the people for the life of the land, to do the jobs that are most needed in those countries —as medical men, agricultural officers, veterinary surgeons and the like. Lord Rennell commented on the need for not only higher technical staff but also for clerical labour, and in particular on the need for a number of educated people, in addition to those already carrying on the administration of the Gold Coast, which the regional and local government system proposed in the Coussey Report will require.

Lord Milverton doubtless had this consideration in mind when he deplored the forcing of the pace of granting political responsibility by those who do not understand the working of a Western democracy; though he may also have been thinking of the feeling of insecurity created by the report of the visiting mission of the Trusteeship Council to which Lord Listowel referred later when speaking of the need for the right conditions for the employment of capital and technical skill. The debate made manifest the support from all political parties in Britain for the stand which the British Government has made against interference with our administrative responsibilities, and for its determination to consider first the welfare of the indigenous inhabitants; it also demonstrated the general desire to associate with other countries in the co-operative attack on common problems and for the breaking down of whatever psychological barriers hinder such co-operation. It is generally recognized that only on the basis of such goodwill and co-operation can we hope to attack, for example, such problems as that of the control of the desert locust, and, as was emphasized at a recent meeting of the Association of Applied Biologists, an attempt is already being made to bring together on a purely technical basis the twenty governments immediately concerned with that problem.

Similar considerations apply to the International Institute of the Hylean Amazon, which, in the absence of informed world opinion, has suffered from considerable misrepresentation. In fact, the Institute has already made a beginning with its essential task of tropical research, and its pilot surveys in the Gurupá region of the lower Amazon and of the Rio Huallaga are likely to throw light on the possibilities of a region little known to science. But essentially the task of the Institute is that of an international laboratory: it is no part of its responsibilities to build the communications, to raise the commercial crops or provide the capital in accordance with the indications of the findings of its experts. The use made of those findings will depend largely on the initiative and interest of the countries concerned, and principally Brazil. That, in turn, will depend on the appreciation and respect which the Institute enjoys among the countries concerned. Here is a specific task of education. In his summing up on the World Resources Conference, the Dutch representative said, "the Conference has shown the need for co-operation between the technical and the social sciences". That might equally be said of the recent report of the United Nations Economic Survey Mission dealing with the plight of the Arab refugees. Its proposals for finding them useful work in Jordan, Arab Palestine, Syria, Lebanon and the Gaza strip are conceived as part of the larger problem of Middle Eastern unemployment, and, on the lines of the Tennessee Valley Authority's method, five pilot projects are suggested for each area, to be centres for fresh production development.

These proposals, which it should be noted have drawn largely on the practical experience of the British Middle East Office, are again not only a good example of technical co-operation by American, British and French experts, but also a challenge to scientific men as well as to statesmen and politicians. All alike must share in the task of education required to provide the basis for wider and further co-operation. The unhappy experience in dealing with the swollen shoot disease of the cacao trees in the Gold Coast and Nigeria should have shown that the solution of even a scientific problem often cannot be secured without regard to social and political or psychological factors. That experience in turn should predispose scientific workers to follow the discussions now proceeding on the report of the Coussey Committee on constitutional reform in the Gold Coast, to which also reference was made in the House of Lords debate. In so far as wise constitutional reform, which endeavours to preserve what is best in existing constitutions and to effect transition from the old to the new as smoothly as possible, favours the establishment of mutual confidence between all sections of the community in the application of constructive measures for dealing with the problem of swollen shoot and other problems affecting welfare and development, something more than an attitude of benevolent neutrality should be adopted.

The working out of sound, orderly and scientific policies of development by the British Government in co-operation with other countries concerned and with the various 'specialized agencies', particularly the American Economic Co-operation Administration, must depend on informed local support. This, in turn, will help in restoring the confidence and sense of security on which the ready flow to Africa and other backward areas of good administrators and technicians depends.

JAN SWAMMERDAM (1637-80)

Jan Swammerdam (12 Februari 1637–17 Februari 1680)

Zijn leven en zijn werken. Door Dr. A. Schierbeek; met een hoofdstuk: De genealogie van Swammerdam en verdere Archivalia, door Dr. H. Engel. (Nederlandsche Monographieën, 6.) Pp. 280+28 plates. (Lochem: N. V. Uitgeversmaatschappij "De Tijdstroom", 1947.)

THE undaunted Dr. Schierbeek, bombed out of two houses during the Second World War, and lamenting the destruction of his valuable library by a misdirected British bomb, has not allowed these grievous trials to damp his enthusiasm or interrupt his sorties into the history of Dutch biology, which are, on the contrary, more vigorously pursued than ever. He is, in fact, at the moment assisting in the momentous task of reprinting and translating into English the classic works of Volcher Coiter on comparative anatomy, which are now unobtainable in their original form and hence meet for reproduction.

The present treatise is a detailed monograph on the life and researches of the renowned Dutch naturalist Swammerdam, and embraces the following aspects of his personality and work: an attempt by Dr. J. de Boer to determine his psychological category; the genealogy of his family by Dr. H. Engel —surely the most exhaustive analysis of the family tree of any biologist ever written; history of the MS. of the "Biblia Naturæ", which was printed in Dutch and Latin in an edition of 450 copies (here Dr. Schierbeek omits the contemporary testimony of Martin Lister); Swammerdam as a collector and preparateur, and his place in the history of preservation methods and research technique; as a physiologist, and his experiments on respiration and muscle–nerve reactions; as a human anatomist, and on the structure of the female genitalia; as a comparative anatomist, and on preformation embryology; and finally as an entomologist and botanist. A bibliography of his chief works and scattered parerga, and identifications of the species investigated by him, are appended. The last mentioned is a useful addition by Dr. C. A. Regteren Altena, who, however, has no suggestions to offer as to Plate 44, Fig. 7, and Plate 45, Figs. 12–20. The former is probably an immature bug of the family Nabidæ, and the latter, according to Niblett, are the galls of *Andricus curvator*, although the fly said to have emerged from them is too badly drawn to be identified.

Dr. Schierbeek has done his work well, as we should expect from so unwearied a disciple of historical research. Our chief and almost only regret is that the book will not be consulted as its importance demands until it is translated into a more familiar language. Not only have Swammerdam's major works been exhaustively studied and assessed, but Dr. Schierbeek has also exploited his own resources in Holland to hunt down the numerous forgotten fragments which so often repay the tedium of finding them. Also, Swammerdam's intercourse with his eminent contemporaries and the extent of their influence on his own work are adequately set forth. The effect of Anthoinette Bourignon's crazy theology on the susceptible Swammerdam was unhappily not the least potent of these influences, and the fact that she was at the time continuously under the delusion that merciless enemies lay in wait to assassinate her failed to warn her followers of the neurotic and subversive character of her personality. Dr. Schierbeek does no more than catalogue the three-volume novel by Klencke entitled "Swammerdam oder die Offenbarung der Natur. Ein kultur-historischer Roman" (1860), and, although it is true this work is seriously inaccurate, it deserves more than a passing mention. The forged portrait of Swammerdam attributed to Rembrandt was recognized by Harting in 1876 as a copy of one of the figures in Rembrandt's "Anatomy Lesson" painted in 1632, five years before Swammerdam was born. The forger was the eighteenth-century painter Jan Stolker. His forgery was first reproduced in zoological literature in the English translation of

Michelet's "The Insect" of 1874, and has since reappeared in many historical memoirs. Dr. Schierbeek correctly affirms that no contemporary portrait of Swammerdam has so far been discovered. His picturesque birthplace, however, now sadly mutilated by drastic repairs, and even scheduled for future demolition, is shown as it was in Swammerdam's time in an old print in the archives of Amsterdam, which Dr. Schierbeek reproduces. An important matter not mentioned by him is that ten of the plates in the "Biblia Naturæ", which include asymmetrical figures, seriously misrepresent the facts owing to the failure of the engraver to reverse the drawings on the copper plates. Dr. Schierbeek reproduces photographically the original drawings of two of these plates, and, as all of them were available to him in Leyden, it is disappointing that he was unable to reproduce more.

The book is well produced; but the binding in cloth of a dead-black colour gives it a somewhat mournful appearance. The plates are reasonably good copies of the excellent line engravings of the first edition of the "Biblia Naturæ".

F. J. Cole

INTRODUCTION TO ANTHROPOLOGY

Man in the Primitive World

An Introduction to Anthropology. By Prof. E. Adamson Hoebel. (McGraw-Hill Series in Sociology and Anthropology.) Pp. xii+543. (New York and London: McGraw-Hill Book Co., Inc., 1949.) 30*s*.

DURING the past two or three years a very large number of anthropological text-books has come from the United States. Among the most recent of these is this volume by the professor of anthropology in the University of Utah, which claims to be no more than an introduction to the subject, but is nevertheless one of the best. After a brief introduction to discriminate between the various fields of anthropology, an introduction notably useful on the relationship between material and non-material culture and on that between social anthropology and sociology, the book is divided into five parts which deal respectively with prehistory, with race, on which the author's views are eminently sane, with primitive society—a long part, amounting to about three-fifths of the whole volume and divided into sub-heads—and with society and culture, which is really concerned with theoretical backgrounds and practical method. It is perhaps this last part that is the most valuable part of the book, containing as it does a brief critical approach to several aspects of recent developments in anthropological work, developments which hold many pitfalls for the unwary and need the more caution from beginners on account of what might almost be described as their meretricious attractions. A glossary of twenty pages, a bibliography and an index complete the volume.

Occasional points arise which either call for criticism or at least challenge debate. It is surely dangerous, for example, to state categorically that the irrigation of rice is an improvement on a more ancient method of growing it dry. It seems more likely to the reviewer that rice reached Indonesia as an irrigated crop and that its dry cultivation there has taken place by the borrowing of part only of the complex. In his otherwise excellent treatment of the incest taboo, the author omits to mention the reason for royal incest found in the descent of property in the female line, so that a prince must marry his sister, or even daughter, to retain the kingdom. In regard to nomenclature, nothing is said of the common practice of giving names of insignificance or humiliation. The treatment of, or rather the allusion to, trial by ordeal suggests perhaps an incomplete acquaintance with the material and psychological factors involved; and the words "so help me God" of a Christian taking oath are not a conditional curse at all, but an invocation of the Deity for help in making a completely correct statement—very often no easy matter. The two chapters on religion (28 and 29) might usefully have included some account of the doctrine of 'soul-stuff', which has been, and still is, an important element in all the religions of south-east Asia and is, as a matter of fact, much more widely spread, since it appears in all continents; fertility cults are also passed over. In one passage the author speaks of the "reported behaviour" of the lemmings, who "supposedly" travel until they reach the sea and are drowned; but this well-known periodic migration of lemmings has been examined in detail by Collett and is not a myth.

Such criticisms, however, relate to matters of minor detail. The book as a whole forms an admirable introduction to anthropology and can be recommended as such with confidence. It is well printed, well illustrated and well indexed, and the price is, for these days, moderate.

J. H. Hutton

MODERN SCIENCE FOR THE LAYMAN

Achievements of Modern Science

By Dr. A. D. Merriman. Pp. xii+272. (London and New York: Gregg Publishing Co., Ltd., 1949.) 21*s*. net.

A New Survey of Science

A revised and enlarged edition of 'Science Marches On'. By Walter Shepherd. Pp. 512+35 plates. (London: George G. Harrap and Co., Ltd., 1949.) 15*s*. net.

DR. A. D. MERRIMAN, who was advisor in scientific matters to the commander-in-chief at G.H.Q. Middle East during the Second World War, has produced a work of high quality. In spite of the ambitious title, "Achievements of Modern Science", he has limited himself to a comparatively few recent applications of physics suggested by technical developments during the War. Concerning these he is a master, and he has the gift of clear, simple exposition without the sacrifice of scientific accuracy.

The book will be useful to many classes of reader, from the member of the Armed Forces to the senior grammar school boy. The topics discussed are rockets and space travel, atomic energy, thermionic valves and cathode-ray oscillographs, radar, electron-microscope, magnetism of the earth and degaussing, the aircraft propeller and weather control—a short list, and one that creates a desire for more from the author, particularly as the book costs a guinea. The diagrams in the text are good, and other features of the work are an appendix of photographic reproductions and a coloured frontispiece of F. O. Salisbury's painting of anti-aircraft batteries in action against flying bombs on the Sussex coast in 1944.

Walter Shepherd's book is a new and expanded edition of the author's previous work, "Science Marches On". The book is well produced, and the illustrations are good. It is unfair to expect scientific omniscience from any author; but I feel that in only five hundred pages too much has been attempted, with the result that at times there is both inaccuracy and scrappiness. The author does not lack enthusiasm, and often he is able to present a difficult principle in a clear and simple manner. At other times, he 'starts too many hares' and makes mysteries where none need be. In a chapter intended to throw some light on the nature and development of mathematics, unnecessary difficulties are made concerning the use of simple non-commutative algebra. Elsewhere, the chain of bones in the middle ear (a marvel of anatomical functional efficiency which the author does notice) is described as "a curious little Heath Robinson arrangement", and further on it is stated that "the camera does not *usually* [my italics] record ghosts". Dr. E. D. Adrian is credited with the discovery of the electroencephalographic alpha-rhythm of the brain, average and normal intelligence are confused, an account of the *Gestalt* psychology makes no mention of Wertheimer, Koffka or Köhler, and, surprisingly, the name of Ernst Mach appears as that of a leading nineteenth-century psychologist. These are typical errors.

There is so much useful material in this readable work that the author should subject it to more careful scrutiny and, where necessary, prune it drastically. More attention should be paid to detail. All books on science should be scientific. W. L. SUMNER

THE SCIENCE OF HUMAN SOCIETY

Social Structure

Studies presented to A. R. Radcliffe-Brown. Edited by Meyer Fortes. Pp. xv+234. (Oxford: Clarendon Press; London: Oxford University Press, 1949.) 25*s*. net.

"RADCLIFFE-BROWN," writes Prof. M. Fortes, "has founded or revived teaching and research in social anthropology in all the five continents." The tribute is as well phrased as it is deserved; its simplicity is more meaningful than all the superlatives in the world. The objective of this book is therefore to demonstrate that it is justified, and this has been achieved in full measure.

Prof. A. R. Radcliffe-Brown's work has been that of a man of science who has devoted his life to the creation of an explicit and systematic theory and method of disentangling the complex customs, beliefs and values of societies unfamiliar to the Western world. His aim is to recreate social anthropology "as a branch of natural science", as a "generalizing science" of human social life, directed to the discovery of universal laws. His efforts in this direction have been a welcome antidote to the overstressing of the subjective element in the social sciences, in which it must be confessed that truth has been sacrificed too often to reputation. So far as this goes, his opinion is that "all that a teacher can do is to assist the student in learning to understand and use the scientific method. It is not his business to make disciples." As Prof. Fortes explains, Radcliffe-Brown has never countenanced the growth of an 'ism' or school based on his theories. "There is," to use Radcliffe-Brown's own words, "no place for orthodoxies or heterodoxies in science."

The kinds of problems that are dealt with by the authors of the individual papers illustrate the extent and the limitations of the science that has been developed in this way, and provide useful examples of the application of Radcliffe-Brown's methods to the solution of individual problems. As a whole, the authors accept his conclusion that social structure is the most important part of social anthropology. They base their work on his two principles of method, namely: that general laws can only be discovered by the comparative study of diverse types of society; and that comparative sociology, like any other science, must start from a hypothesis, test it by field-work, modify it in the light of the results obtained and build them into a systematic body of knowledge. The pattern of the essays, therefore, runs from the general to the particular, and back again to the general. This is evident, for example, in Dr. Margaret Mead's contribution on character formation, and in Dr. F. R. Eggan's work on the Hopi and the lineage principle. It is also the foundation on which Prof. M. Gluckman builds his investigation of the role of the sexes in the Wiko circumcision ceremony, a foundation which is even more plainly apparent in Prof. R. W. Firth's discussion of authority and public opinion in Tikopia. Both these latter essays demonstrate how, by applying the methods of scientific research, otherwise meaningless experiences and observations can be organised into a meaningful whole and be made the basis for further research to test extended hypotheses.

The theories that are thus presented are, of course, rather at the beginning than the end of their development. Both the methods and the generalizations of social anthropology are, as Prof. Fortes points out, "very tentative". Most of the problems of method are still unsolved, and it is a great pleasure as well as something of an intellectual challenge to find them faced with the courage and skill which he displays in his most interesting Ashanti case study. His solution of the basic problem of measurement is to hold that "culture . . . and . . . structure . . . denote complementary ways of analysing the same facts". The former, he argues, gives us the qualitative aspects of social facts; the latter, on the other hand, is "most appropriately applied to those features of social events and organizations which are actually or ideally susceptible of quantitative description and analysis". This formulation presents almost as many difficulties as it clears up; but before the ardent young intellectual begins to pick holes in it, he should ask himself how he can replace it with something better. It is certainly of a somewhat crude and rule-of-thumb order; but it is a step in the right direction in so far as it will lead, if it is followed up, to a clarification of concepts of which the social sciences stand in somewhat desperate need.

It is probable that further analysis of the problem of method will also bring with it a more sophisticated conception of the nature of the anthropological 'laws', the formulation of which has exposed Radcliffe-Brown to such sharp criticism. What is wanted from the anthropologist in the future is, therefore, that the excellent work that has been accomplished in the past fifty years should be continued in the future with even more emphasis on the strengthening of the theoretical foundations on which it rests.

T. S. SIMEY

JUBILEE OF THE NATIONAL PHYSICAL LABORATORY, TEDDINGTON

ON January 1, 1900, Richard Glazebrook took up appointment as director of the National Physical Laboratory. The Laboratory was then at Kew, but shortly afterwards moved to its present site at Teddington. Its formal terms of reference specified its work as being the standardization and verification of instruments, the testing of materials and the determination of physical constants; but in his speech at the opening of the new buildings at Teddington in March 1902, the Prince of Wales, later King George V, said:

"The object of the scheme is, I understand, to bring scientific knowledge to bear practically upon our everyday industrial and commercial life, to break down the barrier between theory and practice, to effect a union between science and commerce. This afternoon's ceremony is not merely a meeting of the representatives of an ancient world-renowned scientific society for the purpose of taking over a new theatre of investigation and research. Is it not more than this? Does it not show in a very practical way that the nation is beginning to recognize that if its commercial supremacy is to be maintained, greater facilities must be given for furthering the application of science to commerce and industry?"

These words were prophetic. The National Physical Laboratory, during its fifty years existence, has not only fulfilled its formal mandate but has also given Great Britain the type of service foreshadowed by the Prince of Wales.

Early in 1900 the staff of the Laboratory was about twelve, and to-day it numbers more than 1,100; but the service it has rendered to the nation, and particularly to industry, cannot be measured merely by this increase in size.

The National Physical Laboratory, unlike most other Government scientific establishments, is organised on the basis of subjects, rather than the service of particular objects. Thus the Building Research Station, for example, is concerned with the application of science to the art of building; but there is no formal limitation to the scope of the National Physical Laboratory, save that its investigations should serve the community through subjects represented by its ten divisions. It is undoubtedly the case that the value of the Laboratory has depended not only on the existence of its specific divisions, but also because those divisions are housed together under the leadership of one director. Despite the fact that the divisions are in many ways almost autonomous, the work of each is influenced greatly by that of the others, and the fact that between them they cover much of the field of physical science has enabled the Laboratory to be the seed-bed in which numerous researches have germinated and grown until they were sufficiently vigorous to lead a separate existence elsewhere. Thus, valuable work which started in the National Physical Laboratory was later transferred to the Road Research Laboratory and the Building Research Station. In more recent times, Sir Charles Darwin, fearing the possible cessation of loose-boundary hydraulics research in Great Britain, instituted work on this subject which was, in due course, transferred to the control of the Hydraulics Research Organisation. It is only lack of facilities elsewhere which is delaying the transfer of the radio work of the Laboratory to the formal care of the Radio Research Organisation. This applies also to the transfer of much of the work of the Engineering Division, and some of the work of the Metrology Division, to the Mechanical Engineering Research Laboratory which is being established at East Kilbride.

In many research establishments the needs are determined by higher authority; but in an establishment working primarily for the general welfare of all industry, and organised by subjects, the needs and problems must, in general, be recognized and formulated by the research workers. The latter is the case in the National Physical Laboratory, which, in this sense, therefore, is similar to a university; but it has been able to meet some needs beyond the scope of universities in the past. The staff, being members of the Scientific Civil Service, have been able to carry on long-term research on a more stable basis than in many universities, where the nature of the research can change suddenly with changes of staff. Also, the possession of large-scale and expensive equipment, most of which was previously beyond the reach of universities, has enabled the Laboratory to work on subjects which universities could not tackle.

In addition to its long-term research, the National Physical Laboratory has fulfilled a very real need in the service which it provides for carrying out special investigations for other government departments and industry. To some extent, therefore, and within its own sphere, it has enabled industry to pay directly for research on subjects where no one firm could provide the necessary facilities. The recent rapid increase in the number of the industrial research associations, numbering no less than forty, has in no way diminished the need for the more fundamental type of work associated with the National Physical Laboratory, in which it endeavours to undertake work meeting the requirements of industry as a whole, leaving to the research associations the direct contact with particular firms. This does not, of course, imply that the research associations are not themselves doing fundamental work; but close collaboration is maintained between the Laboratory and many of the associations, and thereby much possible duplication of effort is avoided.

In addition to its important role in the maintenance of the physical standards, the National Physical Laboratory continues to serve industry by testing and verifying instruments and materials. Much of this work can now be done in the production industry concerned, but the Laboratory has an increasing responsibility in setting the standards for such work, and is prepared in appropriate cases to assist industry to carry out its own tests and verifications by defining and verifying the sub-standards needed for this purpose, and by keeping a sample check on the products. Thus it is the constant aim of the Laboratory to provide those services which industry is not already able to supply on its own account. In some ways the high reputation which the Laboratory has earned is now an embarrassment, because purchasers, especially those in foreign countries, often demand National Physical Laboratory certificates when industry itself is competent to certify its own products.

As is well known, for the first seventeen years of its life, the National Physical Laboratory was under the direct control of the Royal Society. In 1918 it was absorbed into the then newly formed Department of Scientific and Industrial Research; but the 'management' of the scientific work of the Laboratory remained the responsibility of the Royal Society, the president and Council of which, acting on behalf of the Privy Council Committee for Scientific and Industrial Research, even to-day appoints the General Board and Executive Committee of the Laboratory. This collaboration between a learned society and a government department is possibly unique. It is certainly a source of surprise to many visitors from overseas; but they agree that this arrangement produces the desired results. The collaboration of the Royal Society and the Department of Scientific and Industrial Research in this connexion was well illustrated by the fact that a reception held on January 30 to commemorate the fiftieth anniversary of the founding of the National Physical Laboratory was sponsored by His Majesty's Government, but was held in the rooms of the Royal Society. The guests were to have been received jointly by the Lord President of the Council, the Minister responsible for the Department of Scientific and Industrial Research, and the President of the Royal Society. Unfortunately, the Lord President was unable to be present to receive the guests, but joined the company later in the evening.

Much has been written and broadcast recently on the work of the Laboratory, and it is not necessary to repeat this; but exhibited at the reception at the Royal Society's rooms were apparatus, diagrams and pictures illustrating the principal work of the Laboratory since its inception. Pride of place was taken by exhibits representing the Laboratory's most important work—the maintenance of the fundamental standards of mass and length, and of derived standards; particularly interesting were those showing the movement from material to physical standards, as in the cases of the standards of length and light. The method of making precision block gauges and the accurate measurement of angles was demonstrated, as was also progress in the design of engineers' measuring instruments, and such recent developments of measuring methods as the continuous measurement by an air gauge of materials in thread or wire form. Work on fluid flow was represented by exhibits of Stanton's work on compressible flow; models of cargo vessels and illustrations of the laminar and turbulent flow of water around ships' hulls; the development of wind tunnels and wing shapes; work on aircraft stability and control, and on flutter; and examples of investigations in the high-speed laboratory.

Throughout the whole, the work of the National Physical Laboratory in the development of instruments was evident, and here exhibits illustrated work on heat-transfer problems; the measurement of temperature; the precise calibration of microphones; and radiation measurement in connexion with the protection of radiological workers. Larger equipment showed developments in the technique of the measurement of creep of metals over the past thirty years, and one item of the Laboratory's war-work was illustrated by a prototype of bomb disposal apparatus.

Work of general importance, both in industry and the home, was illustrated by exhibits on heat-transfer investigations, including problems relating to refrigerated transport; sound insulation and noise reduction; the development of light alloys and research on calorimetry. Work on high-voltage measurements, devices for frequency measurement, and instruments for the investigation of dielectrics were shown, as well as illustrations of the progress of research in radio-wave propagation and direction-finding, and radio aids to meteorology. Progress in work on the development of an automatic computing engine was illustrated by a simulator, using relays instead of valves.

An exhibit organised by the Test House showed the testing and certification for industry of instruments such as barometers, hydrometers, thermometers, volumetric glassware, taximeters and petrol jets.

Being largely commemorative, the exhibits dealt mainly with the past work of the National Physical Laboratory—or the 'N.P.L.', to use its familiar title. Its future lies along the road of further applied research in the physical sciences, with particular reference to those problems needing special instrumentation and exact measurement, not only to fulfil the known needs of industry, but even more to provide within its sphere the basic knowledge which is the foundation on which future industrial development will be built.

SEVENTH INTERNATIONAL CONGRESS FOR APPLIED MECHANICS, 1948

THE Seventh International Congress for Applied Mechanics was held at South Kensington, London, in the Imperial College of Science and Technology, during September 5–11, 1948. Among the 882 members who enrolled were large numbers from the United States, France, Holland, Italy, Belgium, Sweden, Czechoslovakia and Poland. Altogether, twenty-nine countries were represented. In spite of the fact that many more people came than previous experience led the organisers to expect, the arrangements worked smoothly. The problem of accommodating so large a party was made easier by the action of the authorities of the Imperial College, who allowed members and their wives to stay in the students' quarters. The task of seeing that everyone, including a large proportion of foreign members, knew what to do and where to go was efficiently carried out by some of the staff and students of the College.

The number of scientific papers presented was so great that it was necessary to divide them into five groups and to maintain each group in continuous session during the working hours of five days. The scientific communications were of two kinds. Five general lectures, intended to cover recent work on subjects which are advancing rapidly at the present time, were delivered by invited lecturers, and 228 shorter papers were given by members about work with which they were connected. The "Proceedings" of the Congress* have now been issued in six volumes, which include nearly all the papers presented. They are not printed but are reproduced photographically from typescript provided by the authors. This process involves reducing all pages to the same size, so that the height and spacing of the letters vary from one paper to the next. The Editorial Committee accepted this want of uniformity in order to gain the great advantages of quick publication and low cost. In all cases, even when the author used small type on a large sheet, the typed letters can be read; but formulæ which have been hand-written by their authors are sometimes difficult to read when reproduced on the reduced scale.

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* Proceedings of the Seventh International Congress for Applied Mechanics, London, September 1948. Introductory Vol., pp. 129; Vol. 1, pp. 9–432; Vol. 2, Part I, pp. 320; Vol. 2, Part II, pp. 321–644; Vol. 3, pp. 312; Vol. 4, pp. 356. (London: Organising Secretary, Seventh International Congress of Applied Mechanics (1948). Imperial College of Science and Technology, 1949.)

Of the five general lectures, three are published in full in the introductory volume. Two of these lectures, by J. Kampé de Fériet and G. K. Batchelor, are on different aspects of turbulent flow in fluids, and the third, by M. Hetényi, is on the present state of development of stress analysis. The two lectures by W. Prager, on recent developments in the theory of plasticity, and by M. J. Lighthill, on high-speed gas flow, are being published elsewhere. An abstract of W. Prager's lecture is printed in the "Proceedings", but M. J. Lighthill's lecture is not referred to, owing, it is understood, to an unfortunate oversight. These lectures illustrate the wide variety which exists in the methods of approach employed by the devotees of applied mechanics. Kampé de Fériet discusses in a most general way the properties of the tensors associated with the spectra of turbulence, and he treats the subject as an exercise in pure mathematics without referring to measurements in actual fluids. Batchelor, on the other hand, avoids mathematics where he can, and concentrates on analytical discussion of experimental work. Prager discusses, from an analytical point of view, the kinds of situation which arise when bodies with ideally defined plastic and elastic properties are strained. Hetényi describes the experimental techniques used to measure distributions of strain which occur in materials as they are used in engineering practice. Lighthill considered the powerful mathematical techniques which have been developed in recent years, partly by himself, for discussing fluid flow at supersonic and high subsonic speeds.

Of the 228 shorter papers presented at the Congress, 211 are published either in full or as abstracts in Vols. 1–4 of the "Proceedings". Vol. 1 contains sixty papers on elasticity and plasticity; Vol. 2 seventy-six papers on aero- and hydro-dynamics, being bound up in two parts; Vol. 3 thirty-two papers on thermodynamics, including heat transfer; and Vol. 4 forty-three papers on dynamics, experimental methods and numerical computations.

Reading the papers in Vol. 1 leaves the impression that the assumptions of the classical theory of elasticity, namely, that strains are small and stresses obey Hooke's Law, no longer satisfy many workers in this subject. Great mathematical difficulties arise as soon as these assumptions are abandoned, and materials are assumed to have properties more like those which occur in Nature. Vol. 1 contains examples of solutions of problems involving large strains in bodies which possess ideal elastic properties, problems about bodies with simple geometrical forms and not-so-simple plastic properties, and bodies with ideally simple plastic properties but less simple geometry. It also contains papers like that of A. M. Willis, on the instability of hollow rubber cylinders with axial symmetry, in which no attempt at analysis is made but interesting experiments are described. Many of the papers relate to practical engineering problems like the buckling of straight columns, the behaviour of continuous beams, the stresses in buildings due to wind load and the behaviour of cantilever spars with shear-resisting skins.

The great variety of problems discussed in Vol. 1 makes it difficult to discern any definite trend in research in elasticity and plasticity. Elastic stability still attracts a number of workers, and the elastic behaviour of structures after suffering collapse due to instability is discussed by A. van der Neut. Two-dimensional problems of flow in an ideal plastic material are considered by R. Hill in several cases where the total strain is large. Plastic waves produced by impact at the end of a wire or rod which possesses a well-defined yield point are discussed by M. P. White and shown to give rise to some curious distributions of permanent strain. Z. Horak writes on the impact of a ball falling vertically on a horizontal plane when it is spinning about a vertical axis.

Vol. 2 contains seventy-six papers, of which twenty relate to flow of compressible fluids, eleven to turbulent flow, six to boundary layers and four to flow with a free surface. The great interest taken in the effects of compressibility was stimulated, no doubt, by the fact that aeroplanes now fly up to, and even faster than, the speed of sound. Fortunately, the subject has proved interesting to some very able young mathematicians who have been willing to keep in touch with experimentalists. The present volume contains evidence that their efforts have proved so successful that it is now possible to understand supersonic as completely as subsonic flow. Among the experimental methods available for studying the flow of compressible fluids, the interferometer, which measures density, has been developed to a high pitch of efficiency by R. Ladenburg, who gives some good examples of its use.

The study of turbulent flow has proved a fertile ground for mathematicians as well as experimentalists. The dynamics of statistically isotropic turbulence, which is very nearly produced experimentally in a wind tunnel by making the air pass through a grid of regularly spaced obstacles, form the subject of papers in the "Proceedings" by Kampé de Fériet, Batchelor, F. N. Frenkiel and C. Lin. In this, the simplest case of turbulent motion, the turbulence is carried along bodily in the air stream, and the dynamical discussion concerns the action of the eddies on one another. The more complicated cases where the mean flow varies from point to point have not yet proved amenable to theoretical treatment; but measurements of turbulence in such cases are here described by A. A. Townsend and by J. O. Hinze and B. G. van der Hegge Zijnen. The effect of damping screens in reducing turbulence is considered by M. L. Dryden and G. B. Schubauer.

A paper by Garrett Birkhoff describes some developments in the theory of fluid flow bounded by free surfaces. The shape of the cavity which can exist behind a body in a stream of fluid is discussed, and the jet theory of the action of a hollow explosive charge lined with metal is explained. Problems involving surface waves are considered by F. Ursell, who gives a theoretical account of the waves produced by the rolling of floating bodies, and by K. S. M. Davidson, who explains why it is that a following sea makes steering difficult in some ships.

Vol. 3 contains thirty-two papers on thermodynamics and heat transfer. Heat transfer between a solid and gas flowing past it at high speeds is rendered a difficult subject by the fact that heat is produced in the boundary layer, and since both conductivity and viscosity depend on temperature, the equations representing the distribution of velocity and temperature near the solid surface are complicated. W. F. Cope summarizes the results of calculations which he made with D. R. Hartree, and gives numerical examples illustrating the difference between these calculations and the earlier ones of Pohlhausen. The measurement of the temperature of low-density gases moving at high speeds presents considerable difficulties. If the gas is slowed down and a thermocouple is placed in a region of slow flow, the temperature there can be corrected to give the temperature in the fast-moving gas ; but the heat transfer from the gas to the thermocouple is so slow that the measured temperatures lag behind the true temperatures. J. E. P. Dunning describes a thermometer in which gas is forced to flow over a thermocouple at sonic speed by applying suction to a pipe surrounding it. This measures nearly the same temperature as the slow-flow thermometer but suffers much less from thermal lag.

Recent progress in the problem of knock in internal-combustion engines is described by Sir Alfred Egerton and N. P. W. Moore. Comparatively simple conceptions like those evoked to explain the experiments of Tizard and Pye cannot explain what is observed when an engine knocks. Chemical actions take place during the compression stroke which 'pre-sensitize' gas which has not yet been touched by the combustion flame. Antiknock compounds affect this gas but do not affect the rate of propagation of the combustion flame. A simple method for measuring the conductivity of liquids is described by E. F. M. van der Held and F. G. van Drunen. This method is useful for corrosive liquids which would damage apparatus commonly used for measuring heat conductivity.

Vol. 4 contains forty-three papers on dynamics, experimental methods and numerical computations. The subjects range from the use of matrices for calculating oscillations of complex elastic structures to papers on the strength of reinforced plastics and a description of a 50-ton dead-weight standard of load for calibrating testing machines. An interesting paper by L. S. Wasserman compares accelerations measured at points on the wing tips and other parts of an aeroplane while landing with accelerations computed theoretically from known elastic characteristics of the machine. Diagrams in this paper show that, in certain positions on the aeroplanes tested, very large accelerations, up to 8*g*, occur on landing.

The calculation of the speed at which flutter may be expected to occur in an aeroplane wing has for some time exercised the minds of aeronautical engineers. In the present volume W. Barrois, J. Simon-Suisse and their colleagues give an account of the numerical methods used in France in making these calculations. They also describe electrical analogues which can be used in this connexion. Among the purely experimental papers, one by C. Mylonas on the distribution of stress in glued joints opens new ground. The stresses in the transparent glue are determined by photo-elastic methods.

The high quality and great variety of the papers in these volumes provide evidence that the science of applied mechanics has plenty of vitality, and that it is attracting the attention of many young people, as well as holding the interest of the older workers. The Congresses for Applied Mechanics are usually held at four-year intervals, and the next one will take place in Istambul in 1952. G. I. TAYLOR

COMMONWEALTH CONTRIBUTIONS TO THE BRITISH DIET

THE Nutrition Society, at its meeting in the London School of Hygiene on January 28, discussed what the British Commonwealth could do to feed Great Britain. In the morning session representatives from those Dominions which are the principal contributors to the British diet, and representatives of the West Indies and the Overseas Food Corporation gave the meeting details of what they are already contributing and what they may be able to do in the future. In the afternoon, the morning papers were discussed, commodity by commodity, by British experts on various foodstuffs. A most valuable symposium resulted.

The meeting opened with a paper by Lieut.-Colonel J. G. Robertson, speaking on behalf of Canada. His Dominion, he said, is the second largest country in the world, but it has a population of only about thirteen and a half million people ; it is therefore a large exporter of food. He explained in some detail the remarkable contribution which Canada made to the solving of the British food problem during the Second World War. To do this she greatly increased her production of many foods. In 1938 she exported 160 million lb. of bacon, and by 1944 she was exporting 660 million lb. to Britain ; cattle marketings were virtually doubled, and Cheddar-cheese production increased by 58 million lb. Canada has also sent a considerable variety of foods to Britain, including wheat, flour, bacon and hams, beef, mutton and lamb, poultry, eggs (shell and dried), cheese, evaporated milk and milk powder, fruit, vegetables, lard, salmon, honey and maple products.

Colonel Robertson also pointed out that during the war years Great Britain found it impossible to pay for all her war expenditure (arms, equipment and so forth) and still meet the bill for her food supplies. Canada helped her unstintingly in the financial field by making gifts of more than two thousand million dollars and interest-free loans of more than one thousand million and also by conversion of certain British assets in Canada into cash to the tune of some four thousand million dollars. So by these means during the War, Great Britain was able to obtain most of her food imports from Canada without actually paying for them. It is important, in appreciating the great effort made by Canada to help Britain during the War, to realize how unfortunate is the dollar position to-day, which forces Britain to buy in soft-currency markets, and to leave a food industry in Canada, greatly expanded to meet the mother country's war-time requirements, with virtually no markets for many of its products.

The Canadians are also faced with the sight of dollars provided by Marshall Aid being compulsorily spent in the United States on foods which Canada has in abundance for export. In recent years, Canada has added millions of acres to the area of grain production by the development of early maturing varieties of wheat and by creating new varieties of rust-resistant wheats. In this way she has made possible the addition of hundreds of millions of bushels to the cereal supply of the world. Given a proper incentive, the Canadians could divert their food production into whatever channels that are required. For example, they could decrease beef production and increase pork products ; they could increase wheat acreage at the expense of oats, barley and rye, and so on. In fact, Colonel Robertson gave the meeting a picture of Canada as a country stacked with surplus wheat, cheese, butter, bacon and hams, eggs, beef, apples, preserved fruits, salmon—a list to make British austerity mouths water—and inhibited only by the barrier of dollar exchange from pouring these dietetic treasures into British laps.

Australia's contributions to the British table were described by Mr. A. H. Heywood, of the Australian Meat Board. Here no dollar difficulties arise, and we find that in the ten months ending in October 1949 Great Britain received from this Dominion 1¼ million cwt. of butter, nearly 400,000 cwt. of cheese, 80,000 cwt. of processed milk, more than twelve million dozen eggs, more than 3 million cwt. of meat (including poultry and rabbits), about 20 million cwt. of cereals, nearly 5 million cwt. of sugar, and more than 700,000 cwt. of dried and canned fruits, not to mention nearly a million gallons of wine. Gargantuan as these quantities of food are, few of the items represent more than twenty per cent of the total import of these particular commodities. Australia also sends miscellaneous products such as edible tallow, copra, whale oil and other fats, fruit juices, jam, tomato products, cakes and puddings. The volume of fruit cake and Christmas puddings exported to Great Britain last year was very great—£1 million worth of fruit cake, together with eight million Christmas puddings. Another significant contribution which Australia makes to the British diet is in food parcels, the price of which is subscribed by the Australian people and therefore costs the recipients nothing. During 1940–48 more than eleven million gift parcels were sent to Great Britain from Australia. The parcels vary between seven and eleven lb. each in weight, and they are still being sent at a yearly rate of about three million. In fact, the parcels use so much meat in the tinned meat which is included in them that the Australian authorities are a little uneasy about the effect of the subtraction of the large amount of meat involved from the normal export channels.

Australia could increase the amount available for export of many of the foods which she sends to Britain; but Mr. Heywood told the meeting that it is in the production of meat that Australia is being looked upon to make the greatest contribution to the diet of Great Britain, which, he remarked, is by tradition a nation of meat eaters, though the meat producers of Australia are a little disturbed by the possibility that the extended rationing of meat in Britain may produce a generation which has lost its taste for meat. The export surplus of mutton and lamb from Australia is largely dependent upon the price of wool. The high prices for this commodity which have prevailed in recent years (due to the fact that the rest of the world still turns to Australia for about two-thirds of the total requirements for fine wool) has caused a rise in the sheep population from its low level of 96 million in 1946 to about 110 million now. Thus it would appear that a great increase in the production of mutton and lamb is possible in the near future. Nevertheless, it is in the increased production of beef that the best prospects are presented. There are vast areas in Australia which, because they are not suitable for the production of wool, remain to be developed for cattle. This is a long-term process; but measures to stimulate production in the near or immediate future are being actively promoted.

Dr. C. Hopkirk dealt with New Zealand's food contributions. This Dominion does not export grain, but in dairy products she makes a major contribution, sending in 1949 140,000 tons of butter and ninety thousand tons of cheese. In 1948 the United Kingdom's imports from New Zealand represented (as percentage of the total imports) butter, 50; cheese, 53; lamb, 65; and mutton, 77; the figure for beef, however, is only 17 per cent. New Zealand is at the moment in a period of seven-year agreements with Britain, of which five years have still to run. Within the scope of this agreement the Dominion is aiming at an annual increase of two per cent of dairy products and an increase of fifty thousand tons of meat. To some extent, of course, this projected increase is governed by the seasons. It so happens that the year 1949 was the best year known for dairy products. In general, the future for increased food production in New Zealand is bright, and there is every possibility that the targets set will be achieved or even exceeded.

The case for South Africa was put forward by Mr. A. P. van der Post. The Union is not, he said, naturally a rich agricultural country, and even to-day is dependent for its bread upon the importation of wheat. There are a great variety of climate and great vicissitudes of Nature. The type of sheep found in South Africa is not the mutton-producing type, and mutton and lamb are, therefore, not to-day sent to Great Britain; nor is beef, since the Union lacks natural vegetation on which the beef cattle can be 'rounded off'. Butter used to be exported to Great Britain in small quantities before the Second World War; but drought and increased local demand in recent years have accounted for all of the Union's production of this commodity. Before the War the Union sent 4–6 million dozen eggs to the United Kingdom, a relatively small proportion of the total imports; but they arrived at a time when supplies from other sources were scarce. It is hoped to increase egg supplies again. It might be possible to supply pork and pork products again, if supplies of maize for use as a feeding-stuff can be assured. The Union supplies substantial amounts of whale oil to the United Kingdom, and an important post-war industry is the production of fish liver oils. Union fish-canners hope eventually to provide greater variety of canned fish for export. Sugar is also exported to Britain, and fruit and fruit products (for example, jam, marmalade, canned and dried fruit, fruit pulp and fruit juices) can be supplied in substantial amounts. Mr. van der Post felt that while the Union cannot hope to equal the record of certain other countries in the supply of large quantities of basic foodstuffs to the United Kingdom, it nevertheless can make a substantial contribution partly in basic and partly in semi-luxury foodstuffs to give variety to the British diet.

Dr. L. F. Wiggins spoke on the West Indian contribution to the British diet and pointed out that, although it sends bananas, cocoa, citrus fruits, coconuts, tinned fruit juices, tomatoes and rum, its main contribution is, of course, sugar. He spoke of the economic difficulties produced by the rapid increase of the West Indian population and stated that one way of increasing the prosperity of the various islands which make up this Colony would be to create new industries based on sugar. Reference in this connexion may be made to the food yeast factory which was set up there. A large variety of organic acids can also be produced from sugar, and also substances such as potassium acid saccharate, which can be used as a substitute for cream of tartar.

The work of the Overseas Food Corporation was outlined by Mr. N. R. Fuggles-Couchman, who remarked that a great deal of publicity has been given to the difficulties met with in connexion with the groundnut scheme, but very little to the very successful sorghum-growing activities centred in the north-east State of Australia, Queensland. He pointed out that it is intended to sow groundnuts in Africa in rotation with other crops such as sunflowers, sorghum and so on, and possibly soya beans. Oil-palm cultivation on a large scale has not been undertaken because of the long period (about seven years) before any return can be expected. It is hoped in the not too distant future to provide an annual oil production of about 57,000 tons, which is still only a little more than a tenth of the estimated deficiency of fats. In Queensland 480,000 acres of land have been purchased since March 1948, and it is proposed to grow sorghum, sunflowers and soya beans and other crops for export to Britain. Pigs and store-cattle are being fattened on sorghum to provide extra bacon and meat. It is also proposed to export sorghum direct to the United Kingdom, where it can be used for fattening stock on the spot.

During the afternoon of the meeting, various commodities were discussed as follows: meat, Dr. John Hammond; fruit, Dr. R. G. Tompkins; cereals, Dr. Albert Green; dairy products, Dr. E. C. Capstick; fats, Dr. C. H. Clarke; bacon, Dr. E. C. Callow; and sugar, Mr. Phillip Lyle. It is impossible to discuss the remarks of these speakers in any detail, but reference may be made to one or two items of interest. Dr. Hammond, for example, pointed out that Great Britain is more dependent now (fifty-five per cent) on overseas meat than before the War, and that the home production of pigs contributes virtually no pork, since all the carcasses are converted into bacon. Dr. Green said that Australian wheats are surprisingly low in protein, and that the protein value of Canadian wheat depends upon whether it comes from the west or east coast. The former contains one per cent less protein, and if, for example, Britain obtained all its Canadian wheat from the west instead of the east, it would cost the public 45,000 tons of protein in a year.

As Dr. Callow pointed out, the Commonwealth supplies of bacon last year represent only about eighteen per cent of the total requirements, and if it is assumed that the present bacon ration in Britain remains at 5 oz. for a year, the Commonwealth contribution, if it does not increase, will represent only ten per cent of the requirements. The difference can only be made up by increased home production or further imports from outside the Commonwealth. Dr. Tompkins said that fruit consumption in Great Britain has fallen from 92 lb. per head before the War to 76 lb. now, of which half is home grown. Dr. Capstick thought that the Dominions had done a wonderful job during the War in helping with the varying demands in Britain for dairy products. He said that the present market is more or less saturated for the type of cheese now being supplied, and that Commonwealth cheese makers might consider shipping varieties other than Cheddar. Another point of interest which he made is that sixty thousand tons annually of pre-war butter in Britain came from countries which are now behind the 'iron curtain', and that this has to be made up from other sources.

The meeting was reminded by Dr. C. H. Clarke that there is a world shortage of oils and fats. Although the *per capita* availability of fat for edible purposes is about equal to pre-war, there is a considerable shortage of soap. Greater use of detergents would not free more fat for food because only low-grade fats are used for soap making. Whale oil at the moment can only be used for food purposes. Hydrogenation provides us with a means of obtaining an enormous variety of fats and oils. Mr. Phillip Lyle said that increased production of sugar in the West Indies comes, not from planting more extensive areas, but by more intensive and improved methods of cultivation of areas already planted. He said that, although the food yeast factory is a good idea, it is difficult to persuade West Indians to eat its product. Some of this is being sent to Great Britain and is sold to manufacturers. The cause of the rise in prices is that there is not sufficient demand for the product to keep the factories working full time.

Dr. W. K. Slater (chairman) wound up an admirably conducted meeting by stressing the difficulties that will arise in feeding the British population as increased home demands are made for various foodstuffs in the countries producing them, and which at present have an exportable surplus that is sent to the United Kingdom.

NEWS and VIEWS

North Staffordshire University College: First Appointments

THE following full-time professors have been appointed in the new North Staffordshire University College which is to be opened in August at Keele, near Newcastle-under-Lyme: Mr. W. B. Gallie, senior lecturer in philosophy, University College, Swansea (*philosophy*); Mr. A. E. Teale, lecturer in philosophy, University of Manchester (*political and moral philosophy*); Mr. I. N. Sneddon, lecturer in natural philosophy, University of Glasgow (*mathematics*); Dr. H. D. Springall, senior lecturer, University of Manchester (*chemistry*); Mr. J. W. Blake, senior lecturer in history, Queen's University, Belfast (*history*); Mr. J. J. Lawlor, lecturer in English in Brasenose and Trinity Colleges, Oxford (*English*); Mr. W. W. Chambers, lecturer in German, University of Leeds (*modern languages*); Mr. S. E. Finer, tutor and research fellow, Balliol College, Oxford (*political institutions*); Mr. S. H. Beaver, reader in economic geography, London School of Economics (*geography*); Mr. B. R. Williams, lecturer in economics, Queen's University, Belfast (*economics*); Dr. V. A. Vick, senior lecturer in physics, University of Manchester (*physics*); Dr. A. R. Gemmell, lecturer in botany, University of Manchester (*biology*); Mr. W. Stewart, lecturer in education, University College, Hull (*education*).

Inland Water Survey Committee

THE Minister of Health, Mr. Aneurin Bevan, and the Secretary of State for Scotland, Mr. Arthur Woodburn, have reconstituted the Inland Water Survey Committee, with membership as follows: Major-General G. Cheetham (*chairman*), Mr. R. H. Cuthbertson, Mr. A. A. Fulton, Mr. W. H. Haile, Mr. M. G.

Ionides, Captain W. N. McClean, Mr. J. D. Peattie, Mr. N. J. Pugh, Mr. L. A. Rhodes, Prof. L. Dudley Stamp and Mr. C. A. Wilson, with, as secretary, Mr. M. R. P. Gregson. The terms of reference of the Committee are to "advise on the Surface Water Survey of Great Britain, on the progress of the measures undertaken, and on further measures required, and, in particular, to make an annual report on the subject". The object of the Survey is to make available to government departments, water undertakers, industry, agriculture and to all who need it, information about the yield, behaviour and quality of the water resources of Great Britain. For the present the Committee will be concerned in the main with surface water. The field-work will be undertaken by the new river boards, which are given wide powers for the purpose, and by water users.

National Foundation for Scientific Research, Brussels

THE twenty-first annual report of the National Foundation for Scientific Research, Brussels, covering the year 1947–48, includes the customary lists of members of the Council, bureau and scientific commissions, and details of research grants made during the year and of publications during 1946–47 and 1947–48. There is also an analysis of the grants made since the creation of the Foundation in 1927 by subjects and by institutions, as well as the first report from the Inter-University Institute of Nuclear Physics established in July 1947. The scientific work of the latter Institute at the Brussels centre has been concerned with photographic plate technique and cosmic rays, with X-ray counters, the separation of isotopes by thermo-diffusion and biological studies of the nucleotides of ribonucleic acid with radio-isotopes. At the Ghent centre an automatic Wilson chamber has been constructed, and the diffusion of neutrons and a new Geiger-Muller counter have been studied, while at Liège the purification of uranium, the fission products of uranium and their concentration and the use of the photographic plate in nuclear physics have been among the subjects investigated. At Louvain, the separation of isotopes, the preparation of organic compounds of uranium, nuclear isomerism, and fluorine derivatives of uranium, and at Mons vacuum pumps, Geiger counters, sources of ions and electronic apparatus, have received attention. Some of these subjects have also been studied at the Royal Military College. Special grants were made by the Foundation during the year for a study of the effect of monochromatic X-rays on the phases of cellular division (205,000 francs), for the establishment of a Centre of Eastern Belgian Dialectology (150,000 francs), to the committee responsible for the preparation of an onomatological dictionary of ancient France (120,000 francs), to the provisional committee for the study of alimentation and nutrition of the indigenous peoples of the Belgian Congo (200,000 francs), and for the reconstitution of the collection of photographs of Coptic documents and manuscripts (50,000 francs).

American Imports of Indian Jute

AN "Economic Analysis of the American Market for Jute and Jute Manufactures", by D. Ghosh, has been issued as Economic Research Memoir No. 2 by the Indian Central Jute Committee, Calcutta (pp. 36, 1949, 1.4 rupees). India is the largest supplier in almost every section of the American jute trade, and although the American market is predominantly one for burlap, there is a large demand for raw jute, and bags and sacks. The study is an attempt to understand the nature of this important market, especially to discover basic relations and interpret broad movements in terms of those relations. While essentially exploratory, it indicates that the aggregate value of imports of jute and jute manufactures into the United States is governed by the same forces as regulate the size of the American national income and determine the value of American imports in general. Moreover, the quantity of the imports changes more or less in the same manner as the physical volume of American industrial production, but the American demand for jute and jute goods tends to increase rather more than proportionately with a rise in the level of income and industrial activity. A statistical note on the demand for hessian in the United States is appended.

Planning in the Fuel Industries

IN an address to the Fuel Luncheon Club on December 20, Lieut.-Commander C. Powell, administrative secretary of the Parliamentary and Scientific Committee, after describing the way the Committee works and some action taken by it in recent years, dealt more particularly with the fuel industry, on which the Committee has already issued three reports. Commander Powell summarized some of the recent statements on coal production for costs, coal utilization, oil from coal, domestic fuel efficiency and the co-ordination of research in gas, coal and the electricity industries, which appear to constitute a serious challenge both to the Committee and to fuel technologists. Exactly what is the best policy to follow, either in the short term or in the long, appears to be unsettled; but the Parliamentary and Scientific Committee is prepared to consult with the experts concerned. In particular, there is still before the Committee the memorandum prepared in 1947 by the Combustion Appliance Makers Association, which maintained that twelve million tons of coal a year could be saved by introducing efficient central-heating equipment and up-to-date domestic fuel burning appliances.

The Young Gannet

ALTHOUGH a great deal is known about the activities of the young gannet (*Sula bassana*) from the day of its birth to the day when it takes to the sea, few observations have been made on its behaviour during the following two or three weeks. During the autumns of 1947 and 1948, G. T. Kay attempted to discover how the young, fat, ungainly bird, which is unable to fly, transforms itself into a powerful flier and slim expert diver capable of feeding itself (*British Birds*, 42, No. 9; September 1949). Kay's observations indicate that, after the young gannet has reached the sea, it is no longer fed by its parents and sustains itself for many days without food. Having developed its wings and lost its fat, it is able to get up first for short flights and then for longer ones until it is strong on the wing. Exactly how it secures its first meal is not known. Either it must dive on fish instinctively when alone or follow the example of older birds with which it is certain to come in contact. The conspicuous plumage of the older birds is probably of value to the young one in enabling it to pick out feeding birds at a distance. It would be interesting to read accounts of the young gannet's behaviour from observers who have witnessed any activity of the young bird in southern waters.

Health Education

THE Central Council for Health Education was formed in 1927 when a group of medical officers of health and other responsible men from local authorities met to consider what could be done in preventing as well as in curing illness. The report for 1948–49 describes what the Council achieved in its twenty-first year and what it plans to do in improving the nation's health. Under the National Health Service Act local authorities now have much wider opportunities for health education, and, on their behalf, the Council is hoping to develop its activities by providing them with more exhibition material and other visual aids. Believing that it can best help local authorities by arranging instruction for "natural health educators" rather than by large-scale propaganda aimed at the general public, the Council proposes to arrange more courses for health visitors, nurses, midwives, sanitary inspectors, food handlers and youth leaders. Among special activities undertaken by the Council during 1948–49 was the focusing of nation-wide attention on food hygiene and means of improving the national diet. During the coming year it is hoped to arrange certain health-education campaigns in industry.

Effect of Ultrasonics on Crystal Development

A PAPER by Franco A. Levi on the action of ultrasonics on the formation of metallic crystals through electrolytic deposits, which has recently appeared in *La Ricerca Scientifica* (Rome, August 1949), is devoted to a description, with two diagrams, of the apparatus utilized and the results obtained. The ultrasonics were generated in water by a piezoelectric crystal, and it was shown that these rendered the deposits less adhesive and in diminished quantity, and, in addition, altered the structure of the crystals that were formed. Such modifications could not, however, be observed when the ultrasonics acted *after* the formation of the crystals. The conclusion is that, while the conditions of the experiment in the first instance were favourable for the production of large crystals and a regular and extensive crystalline formation, the intervention of ultrasonics during the formation of the crystals disturbed the crystal growth and was responsible for a fine structure in the deposits.

Russian Periodicals: Translated Contents Lists

THE Department of Scientific and Industrial Research is issuing a series of "Translated Contents Lists" of Russian scientific and technical periodicals (see *Nature*, November 5, 1949, p. 777). This list is the outcome of the co-operation of several organisations; but most of the periodicals mentioned are available in the Science Museum Library, South Kensington, London, S.W.7. The Intelligence Section of the Department is prepared to assist in the location of a particular part of a periodical where difficulty arises, and it is stated that it may be possible to lend periodicals, of which translated contents lists are required, to organisations which are prepared to assist but do not themselves receive the periodicals. A recent number (No. 4; pp. 59; September 1949) covers the contents of twenty-three periodicals in such varied fields as biochemistry, electrical engineering, medicine, radio-technics, technical physics, chemistry, mathematics and surgery. The keeper of the Science Museum Library issues an invitation to all organisations preparing translations of Russian scientific and technical articles to forward one copy of each translation to the Science Museum Library. Translations accepted will be catalogued and listed in the list of accessions of the Library.

New Portuguese Medical Journal

THE first issue (pp. 104; August 1949) of the *Revista da Associaçao Médica de Minas Gerais*, published under the direction of Dr. Aulo Pinto Viegas, with the help of a distinguished group of Brazilian medical men, contains nine original articles, shorter contributions under the heading "De Rebus Pluribus", one book review and some abstracts of articles in other journals. Among the subjects discussed in the original articles in this first issue are the endocrine activity of the seminal epithelium, pulmonary tuberculosis as a complication of diabetes mellitus, red-cell sedimentation, cysts of the lung and the bacteriological diagnosis of the salmonelloses. All these are in the Portuguese language without summaries in English. A publication like this, which will give to the world the experience of South American medical men on a variety of subjects, cannot fail to be useful. Four numbers of the journal will be published each year, and correspondence should be addressed to Caixa Postal 260, Belo Horizonte, Minas Gerais, Brazil.

Chemisches Zentralblatt

AN announcement from Verlag Chemie, Weinheim and Berlin, states that the *Chemisches Zentralblatt*, which has been appearing in two parts, will as from January 1950 be published in its traditional form in one issue and will cover all chemical literature. This abstract journal was for many years the most complete of its kind, and gave more information than could usually be found elsewhere. It also abstracted more publications and dealt with aspects of chemistry not covered in other abstract journals until more recently. The new annual price will be DM. 250.

Automatic Control Mechanisms

DURING the Second World War great advances were made in the design and use of automatic control mechanisms for gunnery and radar, and now with the special requirements of new industrial processes, etc., a need is felt for some organisation devoted to encouraging progress in this subject. Engineering societies discuss some of its aspects on occasion; but the difficulty appears to be that the fundamentals of control are common to all branches of engineering and overflow into mathematics, physiology and psychology. On the initiative of certain members of the government inter-departmental Technical Committee on Servo-mechanisms, an attempt is now being made to bring together those who are interested in the scientific, technical and educational aspects. A sub-committee has been formed, and the Society of Instrument Technology has been approached with the view of forming a control section within the framework of the Society. This has been welcomed by the Society, and it is proposed that the section should cover the theory and practice of closed-loop control systems, including servo-mechanisms, regulators and process controllers, and also problems of the human operator as a controller and when part of a larger control system. An inaugural meeting will be held on March 28, at 6.30 for 7 p.m., at the Royal Society of Tropical Medicine and Hygiene, Manson House, Portland Place, London, W.1, when three short papers will be read: Prof. K. A. Hayes, "Servomechanisms: Recent History and Basic Theory"; Dr. A. Utley, "The Problem of Stabilisation"; and Prof. A. Tustin, "Problems in Control Systems which await Solution". All who are interested in control mechanisms and allied subjects are invited to attend the inaugural meeting. If sufficient response is obtained, the inaugural meeting will be followed by a business meeting to deal with the formation of a control section of the Society of Instrument Technology.

International Conference on Spectroscopy at Radio-Frequencies

An International Conference on Spectroscopy at Radio-Frequencies will be held in Amsterdam during September 18–23. The Conference is being organised by the Netherlands Physical Society and supported by the International Union of Pure and Applied Physics. It is intended to have a number of introductory lectures on nuclear, paramagnetic and ferromagnetic resonance and on precision determination of atomic and molecular constants by radio-frequency methods, and these lectures will be followed by discussions. There will be other discussions at the sectional meetings. Further information can be obtained from the secretary of the organising committee, Prof. J. de Boer, Bunsenstraat 98, Amsterdam-0.

Conference on the Physics of Lubrication

A joint conference on the physics of lubrication has been organised by the Manchester and District Branch of the Institute of Physics and by the British Rheologists Club, and will be held in the Physics Department, University of Manchester, during June 29 (2 p.m.)–July 1 (noon). It is intended to devote sessions to fluid-film lubrication, boundary and extreme pressure lubrication and the physics of lubricants. Suggestions for papers will be welcomed and should be sent, as soon as possible, to the conference secretary, Mr. D. A. Crooks, Imperial Chemical Industries, Ltd., Dyestuffs Division, Hexagon House, Manchester.

Chemical Society: Annual Meeting

The annual general meeting of the Chemical Society will be held this year in the King's Buildings, University of Edinburgh, during March 29–30. The presidential address, by Sir Ian Heilbron, will be on "The Chemical Society—a Mid-Century Review", and Prof. G. Hevesy, who has been awarded the Faraday Medal of the Society, will give the Faraday Lecture, his subject being "The Application of Radioactive Indicators in Biochemical Studies". The anniversary meeting of the Royal Institute of Chemistry, to be held in Glasgow, follows on March 31 and April 1.

Royal Society Lectures for 1950

Royal Society Lectures for 1950 will be delivered as follows: Croonian Lecture, on June 15 by Prof. F. M. Burnet, director of the Walter and Eliza Hall Institute, Melbourne; Bakerian Lecture, on May 4 by Prof. P. W. Bridgman, Lyman Laboratory of Physics, Harvard University; Ferrier Lecture, on June 29 by Prof. J. Z. Young, professor of anatomy, University College, London; Wilkins Lecture, on December 14 by Prof. F. J. Cole, emeritus professor of zoology, University of Reading. The first Leeuwenhoek Lecture will be delivered on November 9 by Sir Paul Fildes, director of chemical bacteriology (Medical Research Council), Lister Institute, London; this Lecture was founded in 1948 by a bequest from Mr. George Gabb "for an annual lecture in the field of microbiology".

Seventeenth National Radio Exhibition at Birmingham

The Seventeenth National Radio Exhibition will be held at Castle Bromwich, Birmingham, during September 6–16. Since its inception in 1922, this Exhibition, which now includes television, has previously always been held in London (when at Olympia, it has been popularly called 'Radiolympia'), and the move to Birmingham this year is obviously connected with the recent opening of the television transmitter in that city. The Exhibition is being organised by the Radio Industry Council (at 59 Russell Square, London, W.C.1) on behalf of the British Radio Equipment Manufacturers' Association, and Mr. F. W. Perks is chairman of the organising committee, which is substantially the same as for the past two Exhibitions.

Postgraduate Scholarships in Agriculture

The Ministry of Agriculture and Fisheries and the Department of Agriculture for Scotland propose to award, for the academic year beginning October 1, or earlier, a limited number of postgraduate scholarships in agricultural economics, husbandry, statistics, and agricultural and dairy engineering. The closing date for applications is May 1. Further particulars can be obtained from the Secretary, Ministry of Agriculture and Fisheries (Research Branch), 1–4 Cambridge Terrace, Regent's Park, London, N.W.1, or the Secretary, Department of Agriculture for Scotland, St. Andrews House, Edinburgh, 1.

Announcements

Prof. E. N. da C. Andrade, director in the Royal Institution, has been elected *correspondant* for the Section of General Physics of the Paris Academy of Sciences.

The triennial award of the Coopers Hill War Memorial Prize and Medal, which fell in 1949 to the Institution of Electrical Engineers, has been made by the Council to Mr. E. D. Taylor, for his paper on "The Measurement of Inter-lamination Resistance on Varnish-Insulated Sheet Steel for Large Electrical Machines".

The Commonwealth Scientific and Industrial Research Organisation has decided to publish two new journals, the *Australian Journal of Agricultural Research* and the *Australian Journal of Applied Science*. These will appear quarterly, and it is expected that four issues of each journal will be published in 1950. Each journal will cost 30*s*. per annum, or 7*s*. 6*d*. per copy. The *Journal of the Council for Scientific and Industrial Research* ceased publication with Volume 21, No. 4 (November 1948).

Mr. J. W. Gruber, of the Department of Sociology, Temple University, Philadelphia, writes that he is collecting material referring to the life and work of the nineteenth-century British anatomist, St. George Jackson Mivart. Mr. Gruber will appreciate any information about Mivart, especially concerning unpublished correspondence.

INACTIVATION OF RIBONUCLEASE IN DILUTE AQUEOUS SOLUTIONS

Action of X-Rays

DALE[1] showed that enzymes in solution in water could be inactivated by irradiation with X-rays and that various other substances, in solution with them, could protect them from this destructive effect of irradiation. This work was, obviously, of the greatest importance to the biologist, as many easily oxidizable substances are present in considerable concentration in the cell and might exert a protective action on such cell enzymes or essential structures as are liable to destruction by the oxidizing radicals produced in irradiated water. Glutathione and ascorbic acid are two substances, normally present in the cell, which might be expected to act in this manner, and the following work was originally undertaken to test this possibility. The work of Barron[2,3], of Dale[4] and of Dale, Meredith and Gray[5] was not then published; but the experiments quoted here, undertaken independently, are in good agreement with the work of these authors.

Crystalline ribonuclease was very kindly supplied by Dr. Kunitz, of the Rockefeller Institute. This enzyme does not contain essential SH-groups and is therefore not reactivated by glutathione after irradiation (see table). Any effect of the glutathione in preserving enzyme activity is due to competitive action.

The enzyme was used in a concentration of $2 \cdot 5 \times 10^{-5}$ gm. per ml. The dose of X-rays used caused approximately 50 per cent inactivation of the enzyme. In any one experiment, the same enzyme solution was used throughout, and the estimations of activity carried out on the same substrate and incubated at the same time. Any variation in experimental conditions therefore affected the control and experimental samples equally.

It was found that a concentration of reduced glutathione equal to two-thirds by weight of that of the enzyme was usually enough to protect completely against the 50 per cent inactivation dose. Commercial samples of glutathione vary in purity, and therefore in effectiveness; but it was found that very little destruction of the enzyme occurred while sufficient glutathione was present to give a definite nitroprusside test for reduced glutathione at the end of the irradiation.

The accompanying table gives the results of these experiments. Oxidized glutathione undoubtedly also exerted protective action; but not enough experiments were carried out to determine whether or not it was actually as effective as reduced glutathione.

In view of the ready protection of the enzyme by glutathione, it seemed possible that the inactivation was caused by the formation of hydrogen peroxide in the irradiated water. The following experiments, however, gave no support to this possibility.

Barron[3] found that catalase protected other enzymes against inactivation by alpha-particles. Hydrogen peroxide was likely to be formed in considerable concentration during the irradiation of water by alpha-particles and would be broken down by the catalase. Catalase does not protect ribonuclease against inactivation by X-rays (see table). In order to avoid a general protective action by the protein of the catalase, the concentrations used were very small; addition of hydrogen peroxide at the end of the irradiation showed that it was still very active.

A negative result here is by no means conclusive proof of the non-participation of hydrogen peroxide in the destruction of the enzyme. Catalase can not only break down hydrogen peroxide, but can also have a peroxidase-like effect and cause oxidation of some substrates in the presence of hydrogen peroxide.

It is known that, in the absence of atmospheric oxygen, the amount of hydrogen peroxide formed by X-rays on pure water is very small indeed. Experiments were therefore carried out to decide whether the inactivation of ribonuclease was less in the absence of atmospheric air. The air was removed by evacuating a solution of enzyme in a vacuum tube;

ACTIVITY OF A GIVEN VOLUME OF ENZYME SOLUTION, BEFORE AND AFTER IRRADIATION

Results expressed as mgm. of soluble phosphorus liberated from 10 mgm. ribonucleic acid. Volume of enzyme and substrate made up to 1 c.c. in each test. Unchanged ribonucleic acid precipitated, after 10 min. incubation at *p*H 5·2, with uranyl acetate in trichloracetic acid. Precipitate discarded, soluble phosphorus estimated in filtrate. Dose of X-rays, 13,500 r units

Control	Irradiated	Irradiated + GSH	GSH added *after* irradiation	Concentration
0·5 c.c. enzyme 0·07	0·032	0·073	0·030	Enzyme 1 mgm. in 20 c.c. Glutathione 1 mgm. in 40 c.c.
0 25 c.c. enzyme 0·027	0·018	0·028	0·017	
Control	Irradiated	Irradiated + catalase		Concentration
0·052	0·034	0·032		Enzyme 1 mgm. in 40 c.c. Catalase 1 mgm. in 160 c.c. Still very active at end.
Control	Irradiated in air	Irradiated *in vacuo*		Concentration
0 064	0·013	0·019		Enzyme 1 mgm. in 40 c.c. Air removed by evacuation and absorption with pyrogallol.
0·019	0 01	0·00		Air removed by freezing to − 195° C. and evacuation. All samples frozen.
		Enzymes exposed to H_2O_2		
Control	with H_2O_2			Concentration
0 5 c.c. enzyme 0·049	0·042	—	—	Enzyme 1 mgm. in 40 c.c. H_2O_2 *M*/20, for 30 min. in dark.
0·25 c.c. enzyme 0·028	0·028			
0·5 c.c. enzyme 0·035	0·038	—	—	The same.
0·5 c.c. enzyme 0·042	0·040	—	—	Fresh sample of peroxide. *M*/100 for 25 min.
0·25 c.c. enzyme 0·026	0·026			

This table contains examples taken from a large number of experiments.

alkaline pyrogallol was present in a side bulb, and 30 min. was allowed between the evacuation of air and the irradiation, in order to allow of the absorption of any remaining traces of oxygen.

In the penultimate experiment quoted in the table, the air was removed by evacuation after freezing the solution at −195° by the method described in the following communication. The freezing caused some loss of enzyme activity; it was thus necessary to freeze both samples and to re-oxygenate one of them before irradiation. It can be seen that inactivation of the enzyme by X-rays did not depend upon the presence of oxygen.

These experiments suggested that the inactivation of the enzyme was not caused by hydrogen peroxide, and, finally, the effectiveness of added hydrogen peroxide in causing inactivation was tried. It was found that none of the concentrations used ($M/1{,}000$–$M/20$) had any appreciable effect on enzyme activity. An occasional slight loss of activity was seen, but this was not constant and did not increase with increasing concentrations of hydrogen peroxide. Precautions had to be taken to prevent sunlight from falling on solutions of enzyme containing hydrogen peroxide. The results are given in the table.

This insensitivity of the enzyme to hydrogen peroxide made it possible to carry out the experiments described in the following communication, in which the enzyme was dissolved in an $M/100$ solution of hydrogen peroxide and suffered no diminution of activity.

It should be pointed out that enzymes containing SH-groups are likely to be sensitive to hydrogen peroxide, and that this might therefore render them more sensitive to irradiation in conditions where the formation of hydrogen peroxide occurs. Barron's work[3] shows that catalase protects an SH-enzyme to some extent against irradiation by alpha-particles and, as he points out, this indicates that here part of the effect of the alpha-particles does depend on the formation of hydrogen peroxide.

The effect of X-rays on the chromosomes of living cells appears to be increased by the presence of oxygen. Thus Thoday and Reed[6] showed that bean roots irradiated in oxygen grew less and formed more chromosome bridges than those subjected to X-rays in nitrogen. Hayden and Smith[7] found that barley seeds irradiated in a vacuum showed a better germination and growth-rate, fewer mutations and less chromatinic bridge formation than those irradiated in air.

In these cases one may suppose that hydrogen peroxide, or radicals formed by the reaction of irradiated water and dissolved oxygen, are, at least in part, responsible for the effects produced by X-rays. In the case of ribonuclease and probably of other enzymes not containing essential SH-groups[5], there is no evidence that dissolved oxygen plays any essential part.

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Aug. 8.

[1] Dale, W. M., *Biochem. J.*, **36**, 80 (1942).

[2] Barron, E. S. Guzman, Declassification Document 484, Lecture at University of San Marcos, "Effect of Radiation on Enzymes" (1946).

[3] Barron, E. S. Guzman, Dickman, S., and Singer, T. P., *Fed. Proc.*, **6**, 236 (1947).

[4] Dale, W. M., *Brit. J. Radiol.*, Supp. No. 1, 46 (1947).

[5] Dale, Gray and Meredith, *Phil. Trans. Roy. Soc.*, A, **242**, 33 (1949).

[6] Thoday, J. M., and Reed, J., *Nature*, **160**, 608 (1947).

[7] Hayden, B., and Smith, L., *Genetics*, **34**, 26 (1949).

Inactivation by Hydroxyl Radicals

THE experiments described in the preceding communication indicate that the inactivation of ribonuclease in dilute aqueous solution by X-irradiation is due to the formation of some oxidizing entity which is not hydrogen peroxide. The possible species which might be concerned are the hydroxyl and hydroperoxide radicals (HO and HO_2). The hydroxyl radical is formed, together with atomic hydrogen, when any nuclear radiation is absorbed in water[1]. The hydroperoxide radical is produced by direct addition of molecular oxygen ($H + O_2 \rightarrow HO_2$) if this is also present in the water.

Since (*a*) it is possible to prepare hydroxyl radicals in water without nuclear radiations, (*b*) the ribonuclease is stable to dilute aqueous hydrogen peroxide (up to 0·05 M), and (*c*) we have developed successful methods for handling aqueous solutions under conditions of extreme deaeration, it was possible to carry out the following experiments to identify the inactivating agent.

(i) Hydroxyl radicals can be generated in aqueous media in a variety of ways[2], of which we have employed the following:

$$(a)\ Fe^{+++}\,H_2O_{aq} + h\nu \rightarrow Fe_{aq}^{++} + H_{aq}^{+} + OH_{aq}$$
$$(b)\ H_2O_{2aq} + Fe_{aq}^{++} \rightarrow Fe_{aq}^{+++} + OH_{aq}^{-} + OH_{aq}$$
$$(c)\ H_2O_{2aq} + h\nu \rightarrow 2OH_{aq}.$$

(*a*) An aqueous solution of ribonuclease containing $1{\cdot}25 \times 10^{-4}$ gm. per ml. was made $10^{-3}\,M$ in ferric alum (analytical reagent quality), to which it was stable. 10 ml. of this solution was thoroughly deaerated by repeated cooling (to −195° C. in liquid nitrogen) and evacuation. Since such treatment was found to result in some loss of enzyme activity, two cylindrical 'Pyrex' glass cells were attached to the bulb in which the freezing was performed. After deaeration, the solution was divided between the cells by rotating the whole system about a ground-glass joint. The two samples were sealed off under vacuum in their respective cells. One of them was immersed in a thermostat provided with quartz windows and illuminated with light from a hot mercury arc for 30 min. The other was kept in darkness in the same thermostat for the same time. Two control samples were treated in exactly the same way except that the ferric alum was absent. In the former case, complete inactivation of the enzyme occurred; in the latter, the inactivation was negligible. Since 'Pyrex' glass cuts off effectively at about 3000 A. and in the solutions used about 90 per cent of light of this wave-length would be absorbed by the ferric salt[3] and only about 3 per cent by the enzyme[4], inactivation in this case can only be attributed to hydroxyl formed in reaction (*a*)*.

(*b*) The experiments with oxygenated and deoxygenated solutions described in the previous communication indicated that the degree of inactivation by X-rays is independent of the presence of oxygen. This indicates that either hydroperoxide radicals are ineffective in destroying the activity, or the enzyme competes successfully with oxygen for hydrogen and no hydroperoxide is formed. The former seems the more likely; but, whatever the reason, exhaustive deaeration is unnecessary and was not, therefore, carried out in the experiments described in this and the following sections.

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* In view of the work of Evans and Uri, *Nature*, **164**, 404 (1949), reaction (*a*) should be written:

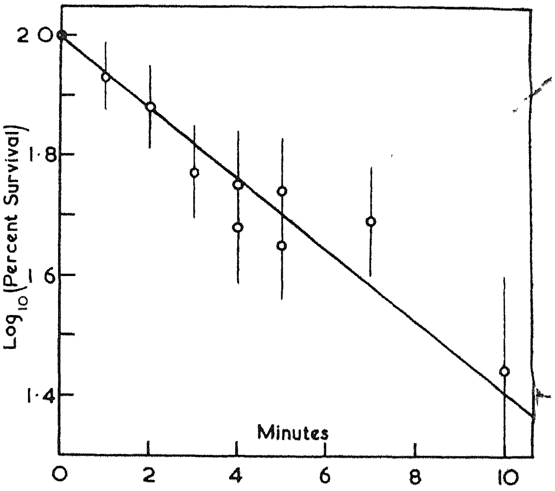
$$Fe^{3+}.OH_{aq}^{-} + h\nu \rightarrow Fe_{aq}^{2+} + OH_{aq}.$$

An aqueous solution of ribonuclease containing $1 \cdot 25 \times 10^{-4}$ gm. per ml. was made 10^{-4} *M* in ferrous sulphate and 10^{-2} *M* in hydrogen peroxide. Control samples were also taken consisting of enzyme in the same concentration together with 10^{-2} *M* hydrogen peroxide and 10^{-3} *M* ferrous sulphate separately. Each solution was allowed to stand for half an hour after preparation before the enzyme activity was assayed.

The ferrous sulphate alone had no effect. The hydrogen peroxide alone produced a negligible decrease of activity; but the combination of ferrous sulphate and hydrogen peroxide brought about complete inactivation of the enzyme during this time. This again indicated that the hydroxyl radical is the entity producing inactivation of the enzyme.

(*c*) In media containing hydrogen peroxide, hydroxyl radicals initiate a chain reaction resulting in destruction of the peroxide and the formation of oxygen gas. When these radicals are formed photochemically according to reaction (*c*), the chain carriers are hydroxyl and hydroperoxide radicals, and any solute which inhibits oxygen evolution from the photochemical decomposition must, provided it is not acting as an inner filter for the light, be reacting with hydroxyl or hydroperoxide or both. In preliminary experiments it was shown that 2·5 mgm. enzyme in 10 ml. of 0·0118 *M* hydrogen peroxide, contained in the reaction vessel of an apparatus constructed for measuring and collecting evolved oxygen from aqueous hydrogen peroxide undergoing photochemical decomposition, evolved no oxygen when illuminated with a hot mercury arc, under conditions where the enzyme-free solution did liberate oxygen. This result, together with those of (*a*) and (*b*) and the previous communication, was taken to confirm the inactivation of this enzyme by the hydroxyl radical.

(ii) In order to discover whether the hydroxyl radicals also react with the inactivated enzyme, it was decided to construct a survival-dose curve[5] under conditions of constant rate of production of hydroxyl radicals. This was achieved as follows. A very small quantity of a solution of hydrogen peroxide, the strength of which was known accurately, was weighed into a flask. The solution was a commercial sample which had been re-distilled under vacuum in a 'Pyrex' apparatus and was about 30 per cent hydrogen peroxide. A requisite amount of a solution of enzyme containing $1 \cdot 25 \times 10^{-4}$ mgm. per ml. to give a concentration of hydrogen peroxide of 10^{-2} *M* was added, the exact concentration being obtained by weighing the solution. Of this solution 10 ml. was pipetted into a cylindrical quartz cell 1 cm. deep and 5 cm. in diameter, having plane ends and two entrance tubes. The cell was fixed by a ground-joint in a given position in a thermostat at 25° C., and the cell contents were irradiated, under constant conditions, by light from a cold mercury lamp of the rare-gas type. The remaining solution was placed in a darkened tube which was hung in the same thermostat for the same period of time as the cell and served as a control. Two other controls were also taken, using another portion of the same enzyme solution. 10 ml. of the enzyme solution alone was put into the cell and irradiated by the lamp, and a sample of enzyme solution in a darkened tube was placed in the thermostat, both for the same time as in the previous case. Assay of the enzyme activity of each solution was carried out as soon as possible after the irradiations were completed. In nearly all the experiments, four such solution analyses were obtained, though in the later ones the control using hydrogen peroxide in the dark was omitted, as it was always found that the reduction in activity produced by it was negligible. The times of irradiation were varied between 0 and 20 min., complete inactivation being obtained in the case of hydrogen peroxide and light after about 10 min. In all cases, at least two assays of enzyme activity were carried out, the percentage inactivation being estimated from the ratio of the volume of control enzyme solution to the volume of irradiated solution required to give the same yield of soluble phosphorus. The lamp gave radiation of wavelength 2537 A. almost exclusively, the reason for this choice of wave-length being that the difference in absorption coefficient of the enzyme and hydrogen peroxide is greatest in this region, ribonuclease having a minimum of absorption at 2520 A.[4].



From the results of these experiments, it was at once possible to plot two curves, one showing the inactivation produced by ultra-violet light alone and the other the inactivation due to hydrogen peroxide and ultra-violet light. Subtraction of the former from the latter led to a curve showing the inactivation due to hydroxyl radicals alone. Slight corrections were made to the points on this curve to allow for the small differences in concentration of hydrogen peroxide in the different experiments, the corrections being based on the values of the absorption for different concentrations of hydrogen peroxide. A plot of log (per cent inactivation) against time yielded a straight line, as shown in the accompanying graph. It was found also that irradiation of a solution of 10^{-2} *M* hydrogen peroxide alone produced 50 per cent decomposition only after a period of 2 hr. It can, therefore, be assumed that over the period of irradiation considered, the concentration of the hydrogen peroxide is effectively constant. Hence the results show conclusively that the inactivated enzyme competes effectively with the active enzyme for hydroxyl radicals.

The relevance of these experiments to the effects produced by absorption of nuclear radiations in living tissue is that they indicate that some of these effects, but not necessarily all, may be due to the action of free radicals or atoms formed from water, where this is the principal component. In the special case of ribonuclease, enzyme activity is destroyed by hydroxyl radicals.

We are indebted to Dr. Kunitz for the enzyme and to the Department of Scientific and Industrial Research for financial aid.

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NON-LOCALIZABLE FIELDS AND RECIPROCITY

THE purpose of the following note is to direct the attention of physicists to a short paper by H. Yukawa[1] which has recently appeared. It seems to me to contain a most important advance in the theory of elementary particles, based on an extremely simple idea.

Yukawa uses two principles which I have suggested at different times but failed to combine, namely: (1) the principle of non-localizability of fields[2] (as Yukawa calls it), which rejects the introduction of co-ordinates and time as independent parameters on which the field operators depend, but proposes to treat co-ordinates and time as observables, represented by operators, and to characterize the space-time dependence of the field quantities by commutation rules; (2) the principle of reciprocity[3], according to which the fundamental equations of physics are symmetrical in space-time and momentum-energy.

The non-localizability of fields is formulated by replacing the derivative $\partial f/\partial x^\mu$ of a field variable f by the commutator $i\hbar^{-1}[p_\mu, f]$, where x^μ are co-ordinates and time, p_μ the corresponding components of momentum and energy, while f is an abstract observable (operator), not a function of the x^μ. However, Peng and I have shown that this apparent generalization alone leads no further than the ordinary theory, since in the representation where the x^μ are diagonal the equations reduce to the usual formalism of field theories.

Concerning reciprocity, it must be admitted that if there is any symmetry of space-time and momentum-energy in Nature, it is not obvious at all in the motions of particles; this objection has been raised again and again in discussions when I tried to explain my ideas. These were actually based on the conviction that a symmetry appearing in the most fundamental law of quantum theory, the commutation rule

$$[x^\mu, p_\nu] = i\hbar\delta_\nu^{\ \mu}, \qquad (1)$$

cannot be accidental, but must correspond to a general invariance principle. Although this is a rather formal argument, it seems to me very powerful if one remembers how fundamental laws of physics have been actually found (relativity, de Broglie waves, positron, meson, etc.). Therefore, Green and I made a new attempt to use the reciprocity principle, by applying it not to the wave functions ψ, which describe the motion of particles, but to the wave operators $F(p)$, which determine the wave equations of free particles, $F(p)\psi(x) = 0$. In this way it is possible to understand the existence of different particles, and to obtain numerical values for their rest-masses. I think that this point of view is of importance.

But now Yukawa has shown that the symmetry, about which there was considerable doubt, in x^μ and p_μ for the wave functions themselves has a perfectly definite and clear meaning, provided the principle of reciprocity is combined with the non localizability of fields. I will indicate his reasoning.

Starting from an ordinary wave equation $\Box U - \varkappa^2 U = 0$ for a scalar wave function U he obtains, by substituting commutators for the derivatives,

$$[p_\mu, [p^\mu, U]] + m^2c^2U = 0, \quad \frac{mc}{\hbar} = \varkappa, \qquad (2)$$

and he supplements this by the reciprocal equation

$$[x_\mu, [x^\mu, U]] - \lambda^2 U = 0, \qquad (3)$$

where λ is a length. Moreover, he adds a third equation which, roughly speaking, expresses the fact that if x^μ is a space-like 4-vector, p_μ is time-like, namely,

$$[p_\mu, [x^\mu, U]] = 0. \qquad (4)$$

The field operator U can be expressed, in the representation where the x^μ are diagonal, as a matrix $U(x', x'')$, where x' and x'' stand for the four components. Then the matrix elements of $x_\mu U$ and Ux^μ are $x_\mu{}' U(x', x'')$ and $x_\mu{}'' U(x', x'')$, respectively, while those of $p_\mu U$ and Up_μ are $-i\hbar \frac{\partial}{\partial x^{\mu\prime}} U(x',x'')$ and $i\hbar \frac{\partial}{\partial x^{\mu\prime\prime}} U(x', x'')$, respectively. This follows from the matrix representation of x_μ and p_μ with the help of δ-functions, namely,

$$x_\mu{}'\delta(x_\mu{}' - x_\mu{}'') \text{ and } -i\hbar\, \delta'(x_\mu{}' - x_\mu{}''),$$

respectively, by performing the matrix multiplication.

Hence the matrix element of the commutator $[x_\mu, U]$ is $(x_\mu{}' - x_\mu{}'')\, U(x', x'')$, but that of $[p^\mu, U]$ is $-i\hbar \left(\frac{\partial}{\partial x_\mu{}'} + \frac{\partial}{\partial x_\mu{}''}\right) U(x', x'')$.

The difference in sign on the right-hand side is the point of Yukawa's remark. It suggests the introduction of the new variables

$$X_\mu = \tfrac{1}{2}(x_\mu{}' + x_\mu{}''), \quad r_\mu = x_\mu{}' - x_\mu{}'', \qquad (5)$$

and $U(x', x'')$ is regarded as a function of these, $U(X_\mu, r_\mu)$. Then the matrix elements of the two commutators $[x_\mu, U]$ and $[p^\mu, U]$ mean simply multiplication by r_μ and differentiation with respect to X_μ of the function $U(X_\mu, r_\mu)$; hence the equations (2), (3), (4) become

$$\left(\frac{\partial^2}{\partial X_\mu \partial X^\mu} - \varkappa^2\right) U = 0, \quad \varkappa = \frac{mc}{\hbar} \qquad (2')$$

$$(r_\mu r^\mu - \lambda^2)\, U = 0, \qquad (3')$$

$$r^\mu \frac{\partial U}{\partial X^\mu} = 0. \qquad (4')$$

Yukawa shows that these equations have a solution which can be written down as a superposition of waves in the X_μ- and r_μ-spaces (8-dimensional Fourier integral). But the significance of the formulæ (2′), (3′), (4′) can be seen without the explicit solution.

There are two sets of variables and corresponding equations for the description of the motion of the particle. One set, X_μ, refers obviously to the motion of the whole; it represents in a certain way the centre. The other set, r_μ, refers to the internal structure. If the dependence of U on the X_μ is given by a factor $\exp(ik^\mu X_\mu)$, (2′) and (4′) reduce to

$$k_\mu k^\mu + \varkappa^2 = 0, \; r_\mu k^\mu = 0. \tag{6}$$

Hence for a particle at rest ($k_1 = k_2 = k_3 = 0$, $k_4 = \pm \varkappa$) one has $r_4 = 0$ and (3′) reduces to

$$(r_1{}^2 + r_2{}^2 + r_3{}^2 - \lambda^2)U = 0,$$

which shows that λ is the 'radius' of the particle.

Yukawa has generalized these considerations to particles with spin and sketched the procedure for field quantization.

The essential point seems to me the demonstration that it is perfectly legitimate to postulate the simultaneous validity of both reciprocal wave equations in x-space and p-space for non-localized fields because, by the nature of the commutators, they split automatically into two sets, one referring to the internal structure, the other to the resultant motion. This idea is so elementary and simple that I expect important results from further development.

M. Born

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SIXTH (U.S.S.R.) CONGRESS ON HIGH-MOLECULAR COMPOUNDS

AN account of a Soviet conference, the Sixth Congress on High-molecular Compounds, which was held in Leningrad in June 1949, has recently been published (N. Mikhaĭlov, *Kolloidnyĭ Zh.* (in Russian), **11**, (6), 444; 1949). The Congress discussed the physics and chemistry of natural and synthetic high-molecular compounds. Thirty-two papers were given under the following headings: (1) mechanical and kinetic properties of high-molecular compounds; (2) physico-chemical properties and methods of research; (3) structure and methods of research; (4) the mechanics of high-molecular substances.

About a third of the papers given were concerned with mechanical and kinetic properties, including contributions by Kh. S. Bagdasar'yan, S. S. Medvedev and co-workers, P. M. Khomyakovskiĭ, V. V. Korshak and co-workers, M. F. Shostakovskiĭ and S. E. Bresler. There was considerable discussion on questions of nomenclature, following the paper by V. V. Korshak. A special committee, composed of the leading chemists in synthetic high polymers, was appointed to prepare the ground for further conferences. A discussion on the kinetics and mechanics of vulcanized rubber was introduced by B. A. Dogadkin. Many new researches were described which will help to further knowledge of the theory of the process of vulcanization.

In the second section the principal speakers were N. I. Nikitin, S. N. Oshakov, the late I. I. Zhukov, P. P. Kobeko, V. I. Ivanov, A. G. Pasynskiĭ and Z. A. Rogovin. The importance of molecular weight determinations was stressed and the various experimental methods were discussed. Problems of molecular structure were considered in relation to methods of research based on the Marxist–Leninist principles of Soviet science.

In the third and fourth sections, the principal speakers were V. A. Kargin, B. A. Dogadkin, N. V. Mikhaĭlov, S. I. Sokolov and G. B. Bartenev. A new method for studying the properties of high-polymer films and solutions on metal surfaces—'the blow-off method'—was described by B. V. Deryagin and N. N. Zakhovaev.

More than a hundred and fifty delegates attended the Congress as well as many guests. Plans were made for the Seventh Congress to be held at the end of 1950 with, for its programme, general questions on the physics and chemistry of high-molecular compounds and the methods of their investigation.

G. W. S. B.

INDEPENDENCE OF FUNDAMENTAL RESEARCH

AN address on "Government Research as an Aid to Secondary Industry", given by Dr. I. W. Wark last August and now published in the *Journal of the New Zealand Institute of Chemistry* (October 1949), is of some general interest, less for the account of the way in which the Division of Industrial Chemistry of the Commonwealth Scientific and Industrial Research Organisation is helping secondary industry, with which Dr. Wark concludes his lecture, than for some of his observations on academic research and conditions of service. Much of what Dr. Wark said about the help given by his Division to the foundry and fell-mongering industries, to wool research, the development of alkaloids from indigenous plants, etc., can be gleaned from the annual reports issued by the Organisation; but his observations on the growth of industrially sponsored work within the universities and leading institutes of technology will be widely welcomed. He recognizes that some such work may be necessary, but strongly opposes a drift from the free research of the endowed university to the controlled research of the dependent university.

Dr. Wark recognizes the danger that the universities may also lose some of their independence if they accept contracts for secret defence research, and he points out that while it may be expedient to sacrifice minor freedoms to preserve the major, it is not easy to call a halt or to draw the line once the process starts. He comments on the different form which the organisation of industrial research has taken in the United States and in Great Britain. While the newer industries have always depended largely on research, the traditional industries also owe their existence to research, though of a far less formal type, and Dr. Wark suggests that one reason why such a country as the United States has not produced more leaders in research is the failure to realize generally that methods adapted to promote efficiency in production are unsuitable when applied to research. He appears to regard the research association of Great Britain as a more satisfactory institution than the research foundation system of the United States, though he recognizes that both systems have their points and that it is unwise to copy either too rigidly or exclusively in other countries, particularly in those such as Australia and New Zealand, with small populations, in which government institutions such as his own Division of Industrial Chemistry may have to shoulder for many years to come wider responsibilities than their counterparts in Britain.

Dr. Wark's comments on the creation of the research associations are interesting. While he approves their creation close to the industries they serve, he suggests they would be doing better work if located in groups or in proximity to the universities. He believes that applied research only flourishes and continues to flourish when prosecuted in proximity to related fundamental work. After a quick glance at conditions in Europe, Dr. Wark points out that for years to come Australia must accept more than she gives in the field of research. Her universities are not developed to the same extent as those of Europe and America and must be built up both to do more research and to train more persons in research methods. They are more dependent on government aid, and Dr. Wark hopes that the Commonwealth Government will be as far-sighted as that of Great Britain and not attempt to curtail liberties in making its grants to the universities. Again, while Australian graduates go overseas for experience in research, those with an interest in fundamental work tend to remain overseas, and the flow in the reverse direction does not yet balance this very serious loss. Moreover, it will not be sufficient to strengthen Australian laboratories unless adequate subsidiary services such as workshops and libraries are provided, and unless the demands for immediate practical results from all research work are stopped. The research worker must be allowed to attack practical objectives on a sufficiently fundamental plane, and the human aspect must also be recognized. Dr. Wark says frankly that frustrations arising from regulations that are useful in other types of work have ruined completely the morale of half the government laboratories of the world.

THE MATHEMATICAL ASSOCIATION

ANNUAL MEETING

THE annual meeting of the Mathematical Association was held at the Regent Street Polytechnic, London, during January 3–4. For his presidential address, Sir Harold Spencer Jones, the Astronomer-Royal, spoke on "The Measurement of Time", describing the search for increasingly accurate methods of time determination, from the earlier transit instruments to the ingenious Shortt clock, with its correlated 'free' and 'slave' pendulums, and the recently devised quartz crystal clock, a timekeeper the accuracy of which is surprising.

On the afternoon of January 3, a discussion on "Mechanics in Schools" was opened by Mr. K. S. Snell (Harrow School) and Dr. E. A. Baggott (Regent Street Polytechnic). Should statics precede dynamics? Should the novice begin with absolute or with gravitational units? What is the place of experimental work in the school course, and what degree of correlation with the physics laboratory is desirable? These questions raised a vigorous open debate, since on none of them was unanimity exhibited.

A paper from Prof. H. S. W. Massey, on "The Method of Mathematical Physics", described the four stages of investigation—the collection and classification of data, the grand inductive hypothesis, and the deductive predictions therefrom, and the experimental verification of these last two stages so as to provide a demonstration of the validity of the induction. Examples of this sequence were given, particularly with reference to fundamental problems in nuclear physics.

On the second day, the meeting began with a paper by Dr. Frank Smithies on "Abstract Analysis". The fundamental concept of the limit in mathematical analysis was successively generalized from the simplest form, familiar to beginners in the calculus, up to the highly abstract notion of a limit in a general topological space, depending on the work of H. Cartan on 'filters' and of E. H. Moore on 'directed sets'. This was followed by an account of "Automatic Calculating Machines" by Prof. D. R. Hartree, in which the recent great development in automatic calculators was illustrated from his wide experience of such machines, particularly the Harvard Mark 1 machine and the electronic delay storage automatic calculator (EDSAC), constructed at the Mathematical Laboratory in Cambridge by Dr. M. V. Wilkes, which is now in operation. Prof. Hartree paid tribute to the great but half-forgotten pioneer work of Charles Babbage (1792–1871); he also deprecated the use of the name 'electronic brain', since these machines "can only do what we know how to order them to perform".

The afternoon of January 4 was occupied with a discussion on "Mathematics in the Comprehensive School", opened by Mr. F. J. Swan and Miss Y. Guiseppi, both of West Norwood County Secondary School. Mr. Swan spoke of the general problems of mathematical teaching in a large Comprehensive School, and Miss Guiseppi described in detail various teaching methods she has designed to give children in the Comprehensive School the mathematics they need in a stimulating form. In the general discussion, it was evident that members of the Association are anxious to protest against the view sometimes held by parents that the Comprehensive School is a 'poor relation' of the Grammar School; they are also deeply concerned with the problem of helping the teacher who may have to teach a good deal of mathematics in such a school but is not a mathematical specialist. Such a teacher cannot afford to join the teaching associations of all the subjects he may be called on to teach; nevertheless, these associations must regard the helping of these teachers as one of the most urgent of their present-day problems.

The final paper, "A Theory of Measurement", by Prof. Herbert Dingle, discussed an interesting philosophical problem. The theory of relativity necessitates some change in the view that a measurement determines the magnitude of some intrinsic property of a body, and Prof. Dingle propounded a definition, developed from a suggestion due to P. W. Bridgman, that a measurement is simply a specifiable operation leading to a number. After exhibiting the ambiguities to which the older view can lead, the speaker showed how the new definition can be used to clarify some points in probability and in quantum theory.

The Association elected Prof. H. R. Hassé, formerly H. O. Wills professor of mathematics in the University of Bristol, as president for the forthcoming year.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

An Electron-Microscopic Investigation of the Cell-wall Organisation of Conifer Tracheids

In the past, considerable controversy has centred upon the interpretation of the observed optical heterogeneity of the secondary-cell walls of conifer tracheids when viewed between crossed Nicol prisms[1-4]. More recent optical observations[5,6], however, have shown the walls of these cells to be composed of three coaxial micellar spirals such that the outer and inner spirals are relatively flat and appear bright between crossed Nicols, while the central spiral is steep and appears dark between crossed Nicols.

To obtain direct evidence using the electron microscope, in support of the above conception of cell-wall organisation in conifer tracheids, it is sufficient that the micellar orientation in either the outer or inner layer should be established, since the existence of a steep micellar spiral in the central layer has been demonstrated by optical[1,4,7] and X-ray evidence[1,3,5]. In the present investigation, the micellar orientation of the cellulose was established for the inner layer of the secondary wall of tracheids of *Pseudotsuga taxifolia*. This was done by preparing 'Formvar' replicas of gold-shadowed tangential longitudinal sections of the wood. The inner surface of the tracheids and the orientation of the specimens were recognized from the spiral cell-wall thickenings of the tracheids, which in the specimens used were inclined at 60° to the longitudinal cell axis.

A micrograph obtained in the above manner is shown in Fig. 1, where the inner layer of the secondary wall can be recognized between the white bands which correspond to the spiral cell-wall thickenings. From this micrograph it is apparent that cellulose fibrils of the inner layer are inclined at approximately 80° to the longitudinal tracheid axis in the specimen used. This observation would thus confirm the type of cell-wall organisation described above.

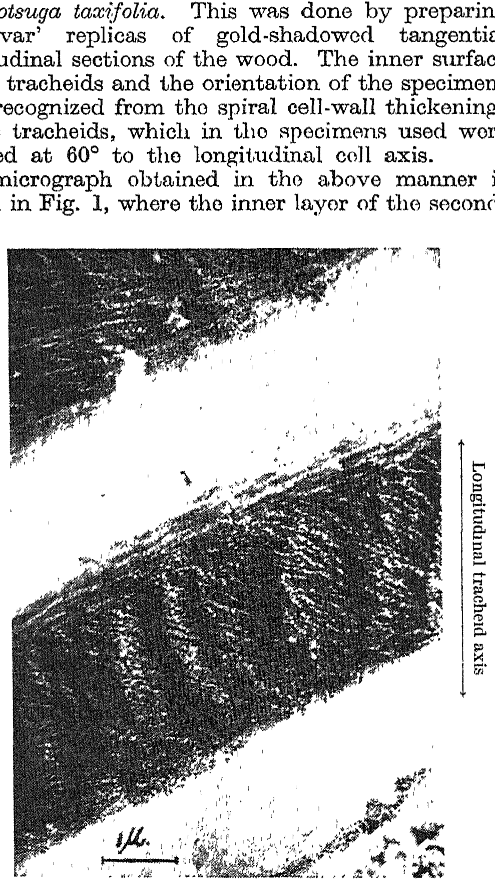

Fig. 1. *Pseudotsuga taxifolia.* Showing striation direction in the inner layer of the secondary wall, which is visible between the spiral thickenings appearing here as diagonal bands across the photograph

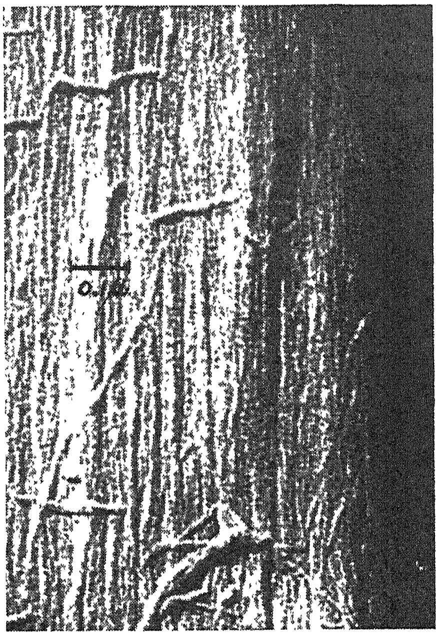

Fig. 2. *Pseudotsuga taxifolia.* Portion of the secondary-cell wall showing parallel orientation of cellulose fibrils 50–100 A. in diameter

In Fig. 1 the fibrillar nature of the cellulose is distinguishable only with difficulty, since it is masked by lignin and other encrusting substances. To investigate this fibrillar structure of cellulose further, delignified sections were disintegrated in a Waring blendor[8] and were examined directly after shadowing with uranium. In photographs of some specimens obtained in this way a uniform fibrillar orientation was observed (Fig. 2), while in others a crossed fibrillar organisation was observed in which the fibrils crossed at an angle of approximately 70°. As yet, however, it has not been possible to establish with any certainty to which cell-wall layer each of these types of organisation belongs.

In many specimens of wood examined (see Fig. 2), as well as in the cell walls of cambium, the fibrils have been found to be 50–100 A. in diameter, which would seem to be in fair agreement with the X-ray estimate of 50–60 A. as the diameter of the micelles[9]. It would thus seem that fibrils such as those in Fig. 2 correspond to the micelles deduced as existing in cell walls on the basis of optical and X-ray evidence. However, in view of the apparently indefinite length of the fibrils (Fig. 2), the present observations, in agreement with those of Preston *et al.*[10], would appear to be more consistent with the concept of the micelle as proposed by Meyer[11] than with the 'fringed micelle' hypotheses[12,13]. It is of interest that the fibrils observed during the present investigation are considerably narrower than those observed by other investigators[8,10].

At high magnification the fibrils (Fig. 2) gave the impression of consisting of a series of small particles

50–100 A. in diameter, placed end to end. This observation was made previously by Farrant[14], and has since been described by other workers[10,15]. If this appearance of the fibrils does reflect an intrinsic feature of their organisation, the possibility of a smaller unit of aggregation would seem to exist.

The above investigations form part of the research programme of the Division of Forest Products and the Division of Industrial Chemistry, Commonwealth Scientific and Industrial Research Organisation, Melbourne. A full account will be given in a later publication.

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Oct. 3.

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A Simple Replica Technique Suitable for the Study of Surface Structures

In the course of some investigations on the minute cuticular hairs of certain insects[1], a replica technique was devised which, by virtue of its simplicity, may be of general interest. The medium of which these replicas were formed was a strong solution of glycerine in gelatin, obtained by steeping powdered gelatin in glycerine for some hours at 50–60° C. until homogeneous. The strength found to be most effective was about 50 per cent w/w; but the exact amounts to be employed are probably best determined by trial, since the nature of the sample of gelatin used probably has an effect. A very small quantity of water added to the mixture was found to hasten and improve the homogenizing process; but too much water should be avoided as it appears to reduce the quality of the replicas by rendering them too soft and plastic. The solution should normally be of such strength as to gelate at about 40–50° C., and set instantaneously below 30° C.; when in use it is conveniently kept liquid by means of a hot-water bath.

In order to make a replica a small quantity of the medium is smeared on a microscope slide kept hot by resting it on a beaker of boiling water. The slide is then removed and the insect placed upon it, touching the gelatin medium at the required orientation while the latter is still molten; the slide is then inverted and dowsed in cold water on the reverse side to set the medium. After 15–30 min. the insect can be removed, leaving a perfect replica of its cuticle in the now hardened medium which is readily examined under the microscope. These replicas do not normally require to be spattered or shadowed to show up the surface relief, but can be examined by transmitted, slightly oblique or dark-ground illumination. They do not shrink and last for several days, since the glycerine is non-volatile; but they should not be squeezed or distorted, as this causes them to lose fine detail.

The great merit of the medium is its elasticity and low adhesion to organic structures, so that neither it nor the specimen is torn or damaged on separation. Even very long, thin hairs which penetrate considerably into the medium come out whole, and leave elongated holes in the replica which can be followed in optical section when examined under the microscope. Hairs which are lying actually at the interface separating the medium from the insect are to be seen in the replicas as hollows or streaks, while parts of the cuticle devoid of or sparsely covered by hairs reveal clearly a pavement-like mosaic probably representing the domains of the hypodermal cells below.

In general, it is found to be much easier to appreciate the shapes of surface structures by making a replica of this kind (remembering, of course, that the replica is inverse) than by examination under vertical or oblique illumination, because the latter method not only produces much scattered and diffracted light but also picks out reflecting or refrangible granules which confuse the overall effect of the surface contour.

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Oct. 11.

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Mass Measurements on Fast Particles Ejected from Cosmic Ray Stars

During the careful investigation of 118 nuclear disintegrations obtained in Kodak *N.T.*4 emulsions, exposed to cosmic rays at the Jungfraujoch (3,650 m.), the identification of particles producing long tracks was attempted.

The plates were calibrated by grain-counting on twelve long tracks formed by light (215 m_e) mesons, identified as such by the decay electrons produced when they came to rest in the emulsion. We thus obtained an experimental curve dN/dR versus R/m, where dN/dR is the grain density (number of grains per 70 μ), R the residual range in microns of the particle of rest mass mc^2 and velocity $c\beta$. From a theoretical R/m versus β curve we could thus construct the curve dN/dR versus β.

If a track has sufficient length in the emulsion, we can determine the mass of the particle that produced it by two independent methods. First, we may determine the difference in grain-density between the ends of the track and see whether such a difference is expected for a meson (π) or a proton track. Secondly, measurement of the small-angle Coulomb scattering determines the quantity $P\beta$ (momentum × velocity), and, obtaining the velocity from grain-density measurements at the beginning of the track, we can determine the mass of the particle. Scattering

Track No.	Initial grain-density	Initial β	Length of track in emulsion (μ)	Expected grain-density at end of track		Observed grain-density at end of track	Mass estimated from scattering measurements	Inference
				(a) Proton	(b) π-Meson			
1	58 ± 6	0·300	800	53 – 66	62–200	62 ± 6	—	Indefinite
2	45 ± 4	0·389	2400	42 – 51	~200	41 ± 3	800 m_e	Proton
3	56 ± 3	0·312	3600	58 – 66	range only ~1300 μ	63 ± 3	—	Proton
4	69 ± 4	0·247	2700	83 –150	range only 700 μ	74 ± 3	—	Proton
5	53 ± 3	0·335	3000	55 – 67	range only 1600 μ	68 ± 6	—	Proton
6	37 ± 3	0·480	4000	35 – 44	35–68	40 ± 4	>3000 m_e	Proton or deuteron
7	68 ± 5	0·309	900	66 – 81	range only 800 μ	68 ± 5	—	Proton
8	46 ± 3	0·416	1200	44 – 51	47–60	45 ± 3	1400 m_e	Proton
9	33 ± 2	0·544	1500	31½– 35½	32½–36½	34 ± 3	>1600 m_e	Proton
10	62 ± 3	0·277	900	61 – 68	~200	63 ± 4	—	Proton
11	34 ± 2	0·523	6400	33 – 38½	38–59	35 ± 2	>1280 m_e	Proton
12	66 ± 3	0·263	1200	67 – 78	range only ~870 μ	69 ± 4	—	Proton
13	35 ± 2	0·507	2100	33 – 37½	35–39	41 ± 3	1100 m_e	Probable proton
14	54 ± 3	0·327	2400	55 – 60	range only 2100 μ	58 ± 3	1800 m_e	Proton
15	62 ± 3	0·283	950	62 – 69	200	70 ± 5	—	Proton

measurements were made at 60-μ intervals along tracks of length exceeding 1,000 μ. It should be noted that if the particle slows down appreciably in the range considered, the scattering measurements give a low estimate of the true mass.

The measurements on fifteen fast tracks are summarized in the accompanying table.

Because of the large spread in mass-value obtained from scattering measurements, it is thought that track number 6 is still consistent with its having been formed by a proton.

From the stars analysed we obtained 76 tracks produced by particles of $0{\cdot}25 < \beta < 0{\cdot}43$ with $\bar{\beta} \sim 0{\cdot}32$. Had these been produced by π-mesons, we should have expected about ten tracks to end in the emulsion. The fact that all these tracks passed out of the surfaces confirms the conclusion drawn from the table that at least 90 per cent (and probably nearly 100 per cent) of particles ejected from nuclei with velocities $0{\cdot}25$–$0{\cdot}43\,c$ are protons. This is in agreement with a previous letter[1], in which it was estimated that only one meson was produced per ten stars, and that with a mean velocity of $\sim 0{\cdot}9\,c$.

The mechanism of ejection of these fast protons is as yet not completely understood. It is not to be expected that such particles are evaporated from a 'heated' nucleus, as are the protons with energies less than 30 MeV. Some are undoubtedly 'knocked on' by the star-producing nucleons, some of which may lose sufficient energy, in such collision processes, so that they finally emerge with energies of only 50–100 MeV.

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Antibiotics from *Aspergillus melleus*

The culture fluid of *Aspergillus melleus* Yukawa was reported by Gill-Carey[1] to show weak antibacterial activity against *Staph. aureus*, *Bact. coli*, *Myco. phlei* and *C. xerosis*. Three antibiotics have now been isolated from culture fluids of this *Aspergillus*. Two of them have been identified: they are penicillic acid and mellein.

The fungus was grown by Gill-Carey on 5 per cent malt extract medium and on a modified Sabouraud medium containing 1 per cent peptone, 4 per cent maltose and 2·6 per cent malt extract. The culture fluid was adjusted to pH 5 and the active material was extracted into chloroform. The acidic substances in the chloroform were extracted into $M/10$ phosphate at pH 8, and the phenols then removed with $N/10$ sodium hydroxide solution. The phosphate extract was brought to pH 3 and the acidic substances extracted into chloroform and chromatographed on a column of 'Florisil' (magnesium silicate). Evaporation of the main active fraction of the percolate left a crystalline residue which was recrystallized from aqueous alcohol. Its melting point, colour reactions and antibacterial properties were identical with those of penicillic acid[2,3]. When mixed with an authentic sample of penicillic acid there was no depression in melting point. It formed a hydroxylamine derivative, of melting point 212° C. [2].

Chromatography of material from one batch of culture fluid (modified Sabouraud medium) yielded a small amount of a second acid which was eluted from the column with an alcohol–chloroform mixture. This crystallized from carbon tetrachloride in long colourless needles of melting point 109° C. (found (Weiler and Strauss): C, 57·0; H, 6·6; $C_{17}H_{22}O$ requires: C, 57·3; H, 6·2 per cent). This acid gave a zone of inhibition 20 mm. in diameter when tested at 1 in 2,000 by the cylinder-plate method against *Staph. aureus*.

The sodium hydroxide solution containing the phenols was acidified and extracted with chloroform. The extract was chromatographed on 'Florisil', when a highly fluorescent substance, with weak antibacterial activity, passed through the column and crystallized from the percolate on evaporation of the solvent. It was recrystallized from aqueous alcohol, forming colourless needles of melting point 58° C. It was almost insoluble in water and in petroleum ether, moderately soluble in chloroform and ether, and soluble in acetone and alcohol (found (Weiler and Strauss): C, 67·3; H, 5·8 per cent). It formed an acetyl derivative of melting point 127° C. and a nitro derivative of melting point 160° C. Mellein, $C_{10}H_{10}O_3$, which melts at 58° C., requires C, 67; H, 5·6 per cent. It yields an acetyl derivative of melting point 126° C. and a nitro derivative of melting point 160° C. [4]; yield, 1 gm. per 5 litres culture fluid.

A second active phenol was eluted from the column with 50 per cent aqueous alcohol; but the quantity was too small for detailed investigation.

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Epicuticle of Blow-fly Larvæ

IT is now clear that in many insects the epicuticle is the waterproofing layer of the cuticle. Although difficult to define morphologically[1], it often carries a wax layer, removable by abrasion or adsorption. *Rhodnius*[2] and *Tenebrio*[3] undergo desiccation after removal of the wax layer by inert inorganic dusts; but blow-fly larvæ are unaffected[4], suggesting a different constitution of the epicuticle. Indeed, the habits of blow-fly larvæ in liquefying the food in which they burrow suggests that the prime function of the epicuticle is other than the prevention of evaporation from the surface of the cuticle. Since the food is liquefied by the secretion on it of the digestive enzymes, it is desirable to discover whether or not a function of the epicuticle is to protect the underlying protein-containing endocuticle against digestion. The great chemical stability of the outer layer of the epicuticle is in agreement with such a view, for it is not dissolved by saturated potassium hydroxide solution heated to 160° C., or by cold concentrated hydrochloric or nitric acids. On boiling with concentrated nitric acid to which potassium chlorate has been added, however, it disrupts into oily droplets which stain with Sudan Black *B*. It therefore appears to be composed of the material termed cuticulin by Wigglesworth[1,5].

Portions of the cuticle removed from larvæ of *Calliphora erythrocephala* have been treated with the fluid obtained from the semi-liquid food by diluting and filtering. After 24 hr. at 25° C., the cuticle became obviously more delicate and transparent, and failed to give readily the ninhydrin reaction shown by the fresh cuticle. After 48 hr. only a delicate membrane, similar to that remaining after treatment with acid, was left. This membrane is the outer epicuticle. No changes occur if the food extract is previously boiled, and it is clear that all the cuticle except the outer epicuticle is susceptible to digestion.

A further experiment consisted of cutting off the anterior and posterior ends of larvæ and removing the body contents from the tubes of cuticle so left. These tubular cuticles were then slipped over glass rods of suitable diameter, some with the epicuticle outwards and some turned inside out to expose the endocuticle. The ends of the cuticle were bound tightly with thread to prevent ingress of fluid between the rod and cuticle, and cuticles arranged in these ways were exposed as before for 48 hr. to the liquid food extract. The result was unequivocal. In those preparations in which the endocuticle had been protected by the overlying epicuticle, histological examination showed the cuticle to be intact, whereas when the endocuticle had been exposed nothing remained but the outer epicuticle.

This protective function of the epicuticle in blow-fly larvæ is to be regarded as an extension into the post-ecdysial period of the part played at every moult in insects generally, when the epicuticle protects the new integument against dissolution by the moulting fluid.

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Quinone Tanning in the Animal Kingdom

PROF. R. DENNELL suggests in his letter in *Nature* of August 27 that quinone tanning of protein structures may be of wide occurrence in the invertebrates. During investigations of structural proteins in the vertebrates and invertebrates, I have found evidence of quinone-tanned proteins in the central capsule membrane of *Thalassicola*, the external cortical layer of the cuticle in *Ascaris lumbricoides*, the chætæ of *Aphrodite*, the byssus[1] and periostracum of *Mytilus edule*, the byssus of *Dreissensia polymorpha* and in the egg cases of various selachian fishes. There are numerous other structures, such as the winter egg cases of planarians and the egg cases of various molluscs and earthworms which suggest, by their colour, the presence of aromatic-tanned protein. Ellerby[2] has evidence for quinone tanning in the cyst wall of eelworms.

Undoubtedly, therefore, quinone-tanned proteins are of widespread occurrence. While these various structures agree in showing very great chemical stability, there is evidence that the sequence of events leading to the tanning differs in different cases. In the tanning of the cockroach oothecæ, the precursor of the quinone is an alcohol-soluble phenol, protocatechnic acid[3,4]. In *Mytilus*, the precursor is not alcohol-soluble, and its properties suggest that it may be an aromatic amino-acid or protein, and there is evidence of a similar precursor in the hardening of the egg cases in *Fasciola hepatica*. If, in these cases, the side-chain is split off before oxidation to a quinone occurs, then the final method of tanning is not significantly different from that in insects. But if oxidation occurs without the removal of the side-chain, then it suggests a way in which quinone tanning may have evolved. Tyrosine is present in nearly all proteins and probably forms salt links through its phenolic hydroxyl group; and it is a comparatively small step to improve on this mechanism by oxidizing the hydroxyl to a quinone, which can form covalent bonds.

It is hoped to publish elsewhere a full report of this work, which was carried out at the Zoological Laboratory, Cambridge, the Marine Biological Station, Plymouth, and Stazione Zoologica, Naples.

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Inhibition of Human Serum Cholinesterase by some 4-Hydroxy-coumarin Derivatives

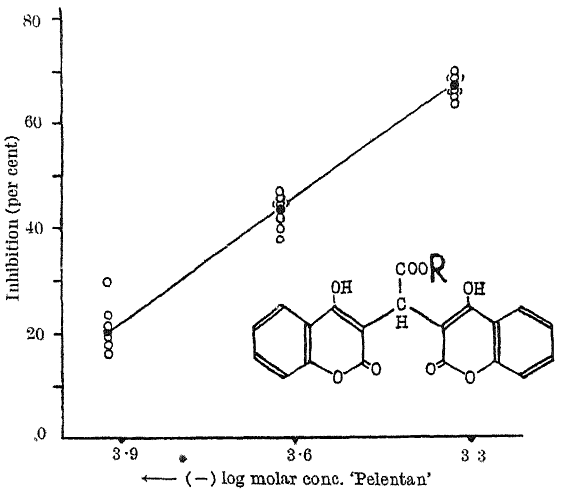
Of the esters of di(4-hydroxycoumarinyl-3)-acetic acid ('pelentanic acid' according to Fučík, Procházka and Čechová[1]), one, the ethyl ester ('Pelentan'), has been widely used as an anticoagulant. It has been reported[2] that 'Pelentan' is less toxic than dicoumarol, acts with less delay and is more quickly eliminated. During a pharmacological study of 'Pelentan', it was found that its solutions inhibit human serum cholinesterase. In continuation of these observations, a comparison has been made of the inhibition of serum cholinesterase by some esters of pelentanic acid and by dicoumarol.

As all these compounds are poorly soluble in water, they were first dissolved with three times their equivalent of sodium hydroxide, and the solutions were then adjusted to *p*H 7·4 with hydrochloric acid. Cholinesterase activity was estimated by Ammon's[3] manometric method. Each determination was made with 0·05 ml. of serum, which had been kept in the ice-box not longer than three days. Serum and inhibitor were placed in the side-bulb and the volume made up to 0·5 ml. with Ringer 30 [4]. Acetylcholine hydrochloride was dissolved in Ringer 30 (1·5 ml.) and placed in the main compartment. The results did not differ when, alternatively, inhibitor was placed in the main compartment.

Cholinesterase activity was expressed in terms of Augustinsson's[4] b_{30}, which represents the volume of carbon dioxide in µl. evolved by the enzyme in 0·05 ml. of serum during the 10th to 40th minute after tipping. Eight to ten tests were made with each compound and with each concentration of 'Pelentan'. Mean values are given in the accompanying table. The variations of the results were small.

The graph shows that the relationship between the negative logarithm of concentration of 'Pelentan' and the per cent inhibition of cholinesterase is linear.

As may be seen from the table, dicoumarol has about half the inhibitory effect of 'Pelentan'. Pelentanic acid, which is derived from dicoumarol by the replacement of one hydrogen of the methylene bridge by carboxyl and has no anticoagulant properties[5], does not inhibit appreciably. Esters of the acid had inhibitory activity increasing with the length of the esterifying radical over the range C_1 to C



Inhibition of serum cholinesterase by 'Pelentan' (R=C_2H_5) of various concentrations; acetylcholine hydrochloride as substrate in molar concentration of $2{\cdot}064 \times 10^{-2}$

INHIBITION OF SERUM CHOLINESTERASE BY DERIVATIVES OF DICOUMAROL
Final inhibitor concentration $2{\cdot}24 \times 10^{-4}$ *M*, acetylcholine hydrochloride $2{\cdot}064 \times 10^{-2}$ *M*

Compound	Mol. weight	% Inhibition
Dicoumarol	338	27·4
R = —H, pelentanic acid (cf. formula)	380	1·9
R = $-CH_3$	394	7·8
R = $-CH_2CH_3$, 'Pelentan'	408	42·7
R = $-CH_2.CH_2.CH_3$	422	54·7
R = $-CH.(CH_3)_2$ (not completely dissolved)	422	(53·7)
R = $-CH_2CH_2CH_2CH_3$	436	54·4
R = $-CH_2.CH.(CH_3)_2$	436	58·7
R = $-CH_2CH_2OH$	424	12·2

Straight- and branched-chain compounds of the same molecular weight were about equally effective. The glycol ester, which differs from 'Pelentan' by one —OH group in the esterifying radical, has a much lower anti-cholinesterase activity; it is also a weaker anticoagulant[6]. 'Pelentan' also inhibits the cholinesterase of rat serum.

Until *in vivo* experiments have been evaluated, no claim can be made of the physiological significance of the inhibition of serum cholinesterase by these anticoagulant drugs.

We are indebted to Dr. K. Fučík and Mr. Z. Procházka of the United Pharmaceutical Works, Prague, for the supply of all the inhibitors tested.

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Demonstration of Incomplete *Rh*-Antibodies by Alpha-Globulin

A method of demonstrating incomplete *Rh*-antibodies by suspending the reacting cells in a concentrated albumin solution has been described by Diamond[1]. The mechanism of the reaction is not clearly understood, and variations in the efficiency of different preparations of albumin suggest that the activating protein is not albumin, but some contaminating protein associated with it.

The fractionation of plasma by ether described by Kekwick, Mackay and Record[2], and afterwards developed for the preparation of gamma-globulin by Kekwick and Mackay[3], made available a protein solution consisting of 87 per cent albumin and 13 per cent globulins which, when concentrated to 10 per cent protein, was found to demonstrate incomplete antibodies. The globulins from a 5 per cent solution of this protein were precipitated with sodium sulphate (18 gm./100 ml. [4]). The precipitate was dissolved in 0·9 per cent sodium chloride solution to one-tenth of the original volume, and the sodium sulphate was removed by dialysis. The supernatant was concentrated and found to be inactive; but the precipitate was active at a third of the protein concentration of the original solution.

Solutions of beta- and gamma-globulin prepared by the ether fractionation of human plasma[3] were found to be inactive; but from the supernatant left after their precipitation an active fraction could be prepared by the addition of 18·5 vol. of ether per cent at − 4° C., *p*H 5·0, and ionic strength 0·035. The active fraction was soluble in 0·9 per cent saline at *p*H 5·0. Electrophoretic analysis of the soluble fraction showed that it consisted of albumin, 38; alpha-globulin, 33·4; beta-globulin, 19·7; gamma-globulin, 8·9 per cent. Albumin, separated electrophoretically from this preparation and concentrated by freeze-drying, showed no activity, but at a comparable protein concentration the globulins were highly active.

Taking all the experiments into consideration, the albumin was consistently negative, and no activity could be found in beta- and gamma-globulin. The activity appears to be associated with alpha-globulin, but no correlation with its concentration could be obtained. It is suggested that this globulin is responsible for the demonstration of incomplete *Rh*-antibody in the Diamond test.

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Glycogen Production from Glucose with Desoxycorticosterone and 11-Dehydro-17-hydroxycorticosterone

It is often said that the different corticosteroids have qualitatively different activities. Desoxycorticosterone is believed to act only on electrolyte metabolism, while 11-dehydro-17-hydroxycorticosterone (Compound *E*) acts on glycogen production. This view is based mainly on results with methods of bio-assay in which adrenalectomized rats on a high-protein diet are given divided doses of these corticosteroids over a period of six hours; two hours after the last injection, liver glycogen is estimated[1-3].

Recently a comparison was made between the glycogenetic property of these two corticosteroids on adrenalectomized rats, which were kept on a pure protein diet[4]. It was confirmed that compound *E* has a distinctly stronger glycogenetic activity, especially after a single injection. In long-term experiments the difference was less obvious.

It was known, however, that desoxycorticosterone restores glycogen production from carbohydrate very well[5]. We have therefore compared desoxycorticosterone in the following experiments with compound *E* on adrenalectomized rats on a carbohydrate-rich diet with continuous treatment. Male rats, 140–180 gm. body-weight, kept on the stock diet, which is rich in carbohydrates, were used. Adrenalectomy was performed from the lumbar side under ether narcosis. Glycogen production was tested in the following way. The animals were fasted for twenty-four hours. Then 2 c.c. of 50 per cent glucose was given by stomach tube; three hours later they were killed, and liver and muscle glycogen estimated[4].

The course of these experiments on normal animals is shown in series 1 and 2 of the accompanying table. After twenty-four hours starvation, the glycogen values are very low; three hours after administration of 1 gm. glucose, they are raised to 3·7–5·7 gm. per cent in the liver and to 0·45–0·55 gm. per cent in muscle.

Untreated adrenalectomized animals, on the tenth to twelfth day, with the first signs of adynamia, showed after glucose feeding a much decreased glycogen production (series 3).

We then treated six adrenalectomized animals for eight days with 1 mgm. desoxycorticosterone daily. Then three animals had for three days 0·5, 1·0 or 2·0 mgm. desoxycorticosterone daily (series 4) and the three other adrenalectomized animals 0·5, 1·0 or 2·0 mgm. compound *E* daily (series 5). On the twelfth day, after twenty-four hours starvation, they were fed with 1 gm. glucose, and after three hours glycogen was estimated. In both groups this was as high as in the normal animals. No difference was found between the action of the two corticosteroids.

In series 6, two animals were treated after the adrenalectomy with 1 mgm. desoxycorticosterone daily, and in series 7 three animals with 1 mgm. compound *E* daily for 15 days. Then, after twenty-four hours starvation, 1 gm. glucose was fed and glycogen estimated after three hours. Normal glycogen values were found in all these animals, as the table shows. For desoxycorticosterone this is only a confirmation of many former experiments.

Thus treatment for several days with 1 mgm. desoxycorticosterone or 1 mgm. compound *E* daily shows equal restoration of the capacity to produce glycogen from carbohydrate sources. While it may be that a larger number of experiments (if more material were available of the latter substance) might show a difference between the activity of these two corticosteroids, these experiments certainly demonstrate that their activity on glycogenesis from carbohydrates is very similar.

Series	Experiment	No. of animals	Glycogen content (gm. per cent) in liver					in muscle				
1	Normal animals—24 hr., starvation	5	0·10	0·10	0·10	0·12	0·10	0·25	0·22	0·34	0·19	0·25
2	Same, but 3 hr. after 1 gm. glucose	5	3·70	3·70	3·75	3·75	5·70	0·45	0·54	0·55	0·45	0·42
3	Adrenalectomized after 10–12 days untreated*	3	1·35	1·43	0·92	—	—	0·37	0·45	0·40	—	—
4	Same, 8 days treated with 1 mgm. desoxycorticosterone, then 3 days with 0·5, 1·0, 2·0 mgm. of it*	3	5·50	4·00	3·80	—	—	0·46	0·45	0·73	—	—
5	Same, 8 days treated with 1 mgm., then 3 days with 0·5, 1·0, 2·0 mgm. *E**	3	5·15	4·75	7·00	—	—	0·59	0·58	0·56	—	—
6	Same, treated 15 days with 1 mgm. desoxycorticosterone	2	3·30	4·70	—	—	—	0·47	0·55	—	—	—
7	Same, treated 15 days with 1 mgm. *E**	3	5·00	2·80	4·80	—	—	0·53	0·44	0·69	—	—

* After twenty-four hours starvation and three hours after 1 gm. glucose *per os*.

We thank Ciba A.G., Basle, for desoxycorticosteroneacetate (Percorten) and Merck, Ltd., Rahway, for compound *E*-acetate which was kindly given for these experiments.

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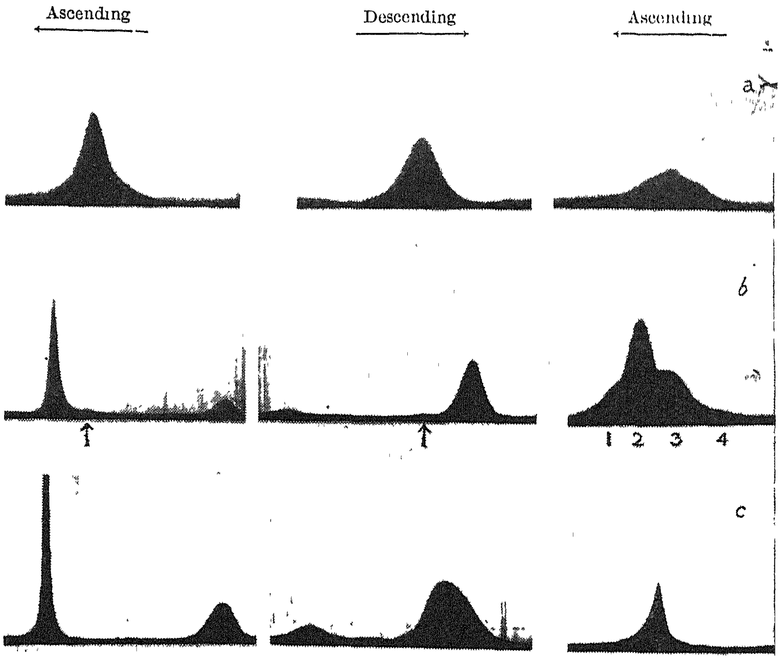
Electrophoretic Heterogeneity of Crystallized Pepsin

CRYSTALLIZED pepsin has been shown by Tiselius *et al.*[1] to give one sharp and a second, diffuse, boundary, visible at higher concentrations only. During electrophoresis, inactive material was removed and the specific activity of the pepsin was raised by 31–69 per cent. These authors concluded that the homogeneity of the migration of the active component is not sufficient evidence *per se* for the chemical individuality of the enzyme. Solubility studies revealed several components possessing different activities (refs. in Sumner and Somers[2]).

With the object of resolving the pepsin into components by electrophoresis, a sample of crystallized pig pepsin (made by Armour Laboratories) was studied in the Tiselius apparatus. By the standard technique 96 per cent of this material appeared to be homogeneous at *p*H 3·9 and 5·9, as well as at *p*H 8, at which *p*H pepsin is inactivated (see illustration, left and centre). The slower component (4 per cent of the total, Fig. *b*) was possibly the same as that observed by Tiselius *et al.*[1] as the diffuse boundary. Prolonged electrophoresis, however, disclosed the heterogeneity of the preparation at all three *p*H's (see illustration, right). The pattern at *p*H 5·9 showed the components most clearly. The percentages of the areas under the peaks were, counting from the fastest component, 1 = 11; 2 = 55; 3 = 24; 4 = 10. On account of the similarity of the mobilities of the components, these values should not be taken to represent the relative proportions of the components in the mixture. The true proportions can be calculated for the case of two components by an equation derived for the limiting conditions of low protein concentrations[3].



Electrophoretic patterns of crystallized pepsin.

	Buffer	*p*H	Ionic strength	Pepsin conc. (gm./100 ml.)	Distance migrated (cm.)	
(*a*)	Acetate	3·9	0·02	0·6	left	3·1
					centre	3·2
					right	10·5
(*b*)	Phosphate	5·9	0·025	0·9	left	2·2
					centre	2·4
					right	29·4
(*c*)	Phosphate	8·0	0·10	1·2	left	2·3
					centre	1·9
					right	20·0

Since the peaks of components 1 and 4 were small, their areas were combined with those of 2 and 3 respectively in order that this equation might be applied. In the derivation of the equation, two assumptions were made[3]: (*a*) that the relative rate of change in migration velocity with protein concentration (expressed in gm./100 ml.) is the same for both components; (*b*) that the relative rate of change of the migration velocity of one component, when at infinitely low concentration, with increasing concentration of the second component, is equal to the relative rate of change of the migration velocity of the second component with increasing concentration of this component. These two assumptions impose fewer restrictions on the choice of the system to be studied than the assumption of constant mobility ratios[4] or constant relative mobilities[5] of all ions. They imply, however, that there is no specific interaction or formation of dissociable complexes of the two colloid components.

The absence of interaction or complex formation can be ascertained when both the ascending and the descending patterns give, at low colloid concentration, the same relative proportions of the areas under the peaks. But if the components differ little in mobility, only the ascending pattern may be available for analysis, and in consequence complex formation cannot be excluded by this means. The reason for the increase in concentration of the faster component ahead of the boundary of the slower component is the decrease in the migration-velocity of the faster component as it leaves the region of the mixture. If a complex is formed between the two components, the average migration-velocity of the faster component in the mixture is decreased; consequently the difference in the migration-velocity of this component below and above the boundary of the slower component is also decreased and the increase in concentration diminished. Minimum values only are therefore given for the concentration of the faster component in the mixture by the equation:

$$\mathbf{C}_l' = \frac{C_l'}{1 + \frac{V_1}{S} K(C_t' - C_l')}. \qquad (1)$$

In the experiment recorded in Fig. *b*, the following experimental values were found: distance migrated at infinitely low protein concentration, $t \times V_l = (t \times V_{al})/(1 + KC_l') = 28\cdot1$ cm. (t is time of migration, V_{al} is actual migration velocity); separation of the peaks, $t \times S = 0\cdot43$ cm.; total concentration below the ascending boundary, $C_t' = 0\cdot70$ gm./100 ml.; apparent concentration of faster component, from area measurements, $C_l' = 0\cdot46$ gm./100 ml.; K, defined as $(1/C_l)\ (V_{al} - V_l)/V_l$, was determined by a differential method[6] in which the concentrations of the dilute upper and the concentrated lower, adjusted solutions were 0·084 and 0·70 gm./100 ml. respectively, $(1/C_t' - C_l')\ (V_{\text{conc.}} - V_{\text{dil.}})/V_{\text{dil.}}$ being used for the calculation as a near approximation. K was found to be 0·035, signifying an increase of 3·5 per cent in the migration velocity of the ascending boundary per unit concentration of pepsin. Inserting the experimental values in equation (1), the true concentration of the faster components (1 and 2) in the mixture, $\mathbf{C}_l'$, is 0·3 gm./100 ml. or 43 per cent of the total; apparent proportion is 66 per cent. The relative difference between the migration velocities of the two main boundaries was 1·5 per cent; the calculated relative difference between the mobilities was 2·3 per cent.

The activity of the enzyme was determined by the method of Anson[7]; the nitrogen concentrations of the protein filtrates and of the pepsin solutions were determined by the micro-Kjeldahl method. Human hæmoglobin was used as substrate. The following specific activities were found, the activity of the freshly made solution being taken as 100: (1) solution of 0·9 gm./100 ml., kept 48 hr. at 0–4° in phosphate at *p*H 5·9 = 112; (2) solution of 0·9 gm./100 ml. dialysed 48 hr. at 0–4° against phosphate at *p*H 5·9 = 122; (3) solution of 0·7 gm./100 ml. taken from the ascending side after prolonged electrophoresis at *p*H 5·9 = 115. The increase in the specific activity after dialysis may be due to removal of inactive material or an inhibitor by dialysis or preferential adsorption on the dialysing membrane.

The patterns of Fig. *b* were obtained after the pepsin had been in solution for not more than 28 hr. The two peaks may represent two different enzymes.

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Hepatic and Splenic Sympathin

Because of the desire to identify the substances liberated by adrenergic nerves, much work has been devoted to the search for really sensitive and specific methods for detecting and estimating adrenaline and allied substances in blood. Some of the difficulties of these estimations in heparinized blood from cats and man have been discussed by Gaddum, Peart and Vogt[1], who selected five sensitive tests for detailed study. By making parallel quantitative assays, closely allied sympathomimetic amines can be distinguished from one another. Using these criteria, Peart[2] found that all the evidence supported the view that the active material released by the adrenergic nerves in the cat's spleen was *nor*adrenaline, although smaller amounts of adrenaline were sometimes also liberated. In a similar series of cats, we now record the proof that the active material is *nor*adrenaline, which may be found in the blood of the splenic vein in concentrations up to 0·3 μgm./ml. plasma. In addition, in six out of fifteen experiments, adrenaline in quantities less than 0·01 μgm./ml. plasma has been detected and estimated, and these amounts were usually found in samples obtained during the first stimulations only[3].

All the work has been completed on cats under chloralose, heparin being used as the anticoagulant. Blood samples were collected from the splenic vein into graduated centrifuge tubes standing in ice, and then centrifuged. The pharmacological tests used for the assays were: (1) inhibition of the rat's non-pregnant uterus in diœstrus, (2) inhibition of the week-old chick's rectum at 37° C., and (3) contraction of the chronically denervated nictitating membrane of a cat under chloralose, injections of the drugs or samples being made into the side arm of a special cannula in the carotid artery[1]. When mixtures of adrenaline and *nor*adrenaline were added to control samples of plasma, accurate estimates were obtained by these tests when the activities were calculated by the formula employed by Bülbring[4]. As little as 4 per cent of one of the amines could be accurately measured in a mixture of the two.

In other experiments, stimulation of the rat's non-pregnant uterus in full œstrus (when cornified cells are in the vaginal smear) was also used as confirmatory evidence, this being abolished by dibenamine. In addition, the samples caused contraction of the cat's spleen and increased the force and rate of the frog heart-beat.

In most cases, stimulation of the nerves was completed in one minute, although the 'post-stimulus' sample of plasma was collected over three minutes (during and following the stimulation period). A typical series of results for the sympathin concentration in the post-stimulus samples of plasma in terms of the two amines is shown in the accompanying table. The pre-stimulation samples had no action when tested in a similar manner, and ligation of the adrenal vessels did not affect the result.

Sympathin concentrations (μgm./ml.) in the post-stimulus samples of plasma in terms of adrenaline or *nor*adrenaline

Sympathin estimated as	Rat non-pregnant uterus in diœstrus	Chick rectum	Cat's nictitating membrane
L-Adrenaline (*A*)	0·0025	0·01	0·25
L-*nor*Adrenaline (*N*)	0·125	0·20	0·25
Ratio *A*/*N*	0·02	0·05	1·0

By formulæ, the mean value for *nor*adrenaline is 0·25 μgm./ml., while the adrenaline value is zero.

Further evidence that the main active material is *nor*adrenaline is provided by the fact that the post-stimulus samples stimulated the rat's non-pregnant uterus in early œstrus (when nucleated epithelial and cornified cells are in the vaginal smear), whereas adrenaline relaxed this tissue at this stage of the œstrus cycle[5].

Using these methods of estimating the sympathin, we have now stimulated the hepatic nerve in cats after attaching two threads around the inferior vena cava, one above the diaphragm and the other between the liver and the adrenal glands. Blood samples, taken from the hepatic vein via a syringe and a No. 13 needle[6], were centrifuged and tested on the preparations described above. The active adrenergic material was *nor*adrenaline, which may be found in the blood of the hepatic vein in concentrations up to 1·05 μgm./ml. plasma. In addition, in two out of twelve experiments, adrenaline in quantities less than 0·003 μgm./ml. plasma has been detected and estimated.

We are proceeding with the investigation in an attempt to identify the sympathin liberated by other adrenergic nerves. The work would not have been possible without the technical assistance of Mr. G. Ayerst, to whom our thanks are due.

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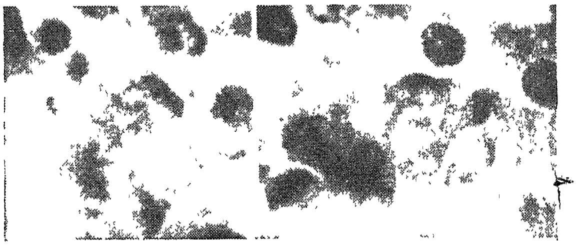
Secretion of Red Blood Corpuscles as Seen in the Camel

WE have been fortunate enough to receive some camel organs which enabled us to proceed with the research on red blood corpuscle secretion in this animal and to complete our previous studies on its eosinophil cells[1]. Some interesting observations were made in the liver, spleen and gastric and intestinal mucosæ.

In the spleen, the development of the eosinophil can be studied at its best, and cells of different sizes can be found containing granules in various stages of evolution, some being fully matured red blood corpuscles. The diameter of some of the cells has been calculated to contain more than twenty of these mature red-blood corpuscles, and it is a remarkable fact that, in spite of their size, some of the granules always retain their oval shape (see photomicrographs). A large number of mononuclears have been found, some of them having a lymphocytic nucleus and containing one or two fully developed red blood corpuscles.

In the liver, occasional eosinophil cells can be seen; but in this organ it is not possible to demonstrate the presence of very large cells in the process of secretion.

The gastric mucosa of the camel enabled us to show that the eosinophil can be linked with the oxyntic cells, as we have established in other animals, especially the Herbivora (cow, sheep and horse). In the camel, however, the oxyntic granules are not so large as they are in the latter animals, and it is more difficult to see them developing *in situ*. If the granules are studied carefully and individually, it soon becomes apparent that they are not round in shape; but some have a definite oval appearance. Similar observations apply to the Paneth cells in the small intestine, and in this organ the eosinophils can be found in large numbers at the top of the villi.



Camel spleen. Blood-secreting cells in different phases of secretion. Notice the oval shape of the granules

This evolution of the eosinophil upholds the secretion of the red blood corpuscles as against the accepted theory of phagocytosis; for if this latter theory were correct, the red blood corpuscles would not require to keep their oval shape or to shrink in size before destruction. Hence the view that fully matured red-blood corpuscles are evolved from the eosinophil is easier to understand than the phagocytosis of the red blood corpuscles which causes the cell to shrink and become an eosinophil.

This work has been made possible by the collaboration of Mr. J. R. Evans, of the Sudan Veterinary Service, and the kindness of Dr. D. O'Brien, who sent me some camel organs spontaneously from Somalia.

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Relation between Vitamin B_{12} and the Red Blood Cells

THE chemistry and biochemical function of vitamin B_{12} are at present the subject of intensive study. A feature which distinguishes this substance from other therapeutic agents is its effectiveness in very small amounts. While the amount which is adequate for the treatment of pernicious anæmia in relapse varies in individual cases, an initial dose of about 10 gamma (that is, 10^{-2} mgm.) is generally effective. The smallness of these effective amounts has aroused comment; but a simple calculation (as follows) shows that the quantities of B_{12} required appear to throw some light on its significance in the blood picture.

The number of B_{12} molecules in 10 gamma can be calculated from the following equation:

$$\text{No. of molecules} = \frac{\text{Wt. of 10 gamma in gm. (gm. mol. No.)}}{\text{Mol. weight } B_{12}} = \frac{10\times10^{-3}\times10^{-3}\times6\times10^{23}}{1{,}300} = 5\times10^{15}.$$

The average number of red blood cells in the blood fluid of an adult human in good health is about 5 million per c.mm.[1]; thus the total number of red blood cells is obtained from this number and the total volume of blood fluid, which is about 6 litres. The total number of red blood cells is therefore

$$5 \times 10^6 \times 10^3 \times 10^3 \times 6 = 3 \times 10^{13}.$$

In the condition of pernicious anæmia in relapse, the number of red blood cells may fall to half this number or even less.

If the number of molecules in an effective dose of vitamin B_{12} is compared with the total number of red blood cells, it is apparent that there is more than enough vitamin B_{12} for a one-to-one correspondence, and there is available an excess for a depot storage in the liver. The close accord of these numbers is very suggestive and the smallness of the therapeutic doses no longer appears surprising, nor does vitamin B_{12} appear to be behaving as a catalyst. Since the effect of injecting vitamin B_{12} is rapidly to raise the number of reticulocytes, the precursors of the erythrocytes, it appears probable that at least one vitamin B_{12} molecule interacts, at an earlier stage of the normoblast process, with one blood cell. Thus it seems likely that the vitamin B_{12} molecule provides in some manner an essential unit for each *individual* blood cell in an early stage of its development. If this hypothesis is valid, then it opens up possibilities for further investigations.

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Minimum and Maximum Limits of Photon-Energy

Milne[1] has recently suggested that Planck's 'constant' h may vary with time, the variation being significant for the interpretation of the spectra of distant galaxies. According to Milne's discussion, h varies linearly with t, the present value of the latter being of the order of 2×10^9 years. This possibility has the particular merit of reconciling the observed red-shifts with the principle of conservation of energy. It is the object of the present letter to point out some other significant consequences of Milne's law.

First, we note that this law has an important bearing on the physical dimensions of Planck's constant. For, if h varies linearly with t, then h/t must be a fundamental constant of energy which, unlike h, will be a secular invariant. Hence, the fundamental constant will now be a natural unit of energy, the value of h at any cosmic epoch being obtained by multiplying this unit by that epoch.

Secondly, we consider the possible identification of this new unit. Taking $h \sim 6 \times 10^{-27}$ erg-sec. and $t \sim 6 \times 10^{16}$ sec., we find that

$$\frac{h}{t} \sim 10^{-43} \text{ ergs.} \qquad (1)$$

This is equal to the inertial energy of a rest-mass,

$$\frac{h}{c^2 t} \sim 10^{-64} \text{ gm.} \sim \frac{m}{\sqrt{N}}, \qquad (2)$$

where m is the mass of the proton and N is Eddington's number 10^{79}. (This number indicates the order of magnitude of the equivalent number of protons in a universe of mass 10^{55} gm., a numerical value which arises in many otherwise widely different theories of world-structure[2].) Substituting $r\sqrt{N}$ for ct in equation (2), we can immediately isolate the well-known fundamental unit of length,

$$r \sim \frac{h}{mc}. \qquad (3)$$

This unit, of course, is comparable with the radius of the proton ($\sim 10^{-13}$ cm.). The length ct, on the other hand, is equivalent to the 'radius of the universe', both in Milne's theory and in Eddington's.

It is natural to ask: What are the minimum and maximum theoretical limits of photon-energy? Since, in standard notation, $E = h\nu = hc/\lambda$, it follows that the minimum E will be given by maximum λ, and it is reasonable to assume that this is comparable with ct. The corresponding $E_{\text{min.}}$ is, therefore, h/t, that is, the fundamental unit of energy already isolated. On the other hand, if we assume that minimum λ is comparable with the fundamental unit of length r, given by (3), the corresponding $E_{\text{max.}}$ is given by

$$E_{\text{max.}} \sim \frac{hc}{r} \sim mc^2, \qquad (4)$$

and so is comparable with the inertial energy of the proton.

These simple calculations suggest further questions: in particular, if m, the mass of the proton, is the largest possible rest-mass for an 'elementary particle', is $m/\sqrt{N} \sim 10^{-64}$ gm. the smallest possible rest-mass, and if so, are there material particles far less massive than any so far observed? If the rest-mass of the neutrino, for example, were of this order of magnitude, its energy and momentum could be significant experimentally provided its velocity were sufficiently close to c.

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Schumann–Runge Absorption Bands in Heated Oxygen

The development in emission of the Schumann–Runge system of O_2, throughout the greater part of the ultra-violet transmitted by quartz, was recently reported by one of us[1,2]. In the region below 2500 A. the necessity of using fast coarse-grain plates resulted in impaired definition, and accurate measurement was not possible. At the same time, well-resolved rotational structure was desirable in this region; first for the continuation of the rotational analysis which has now been performed for most of the new bands lying above 2500 A.[3]; secondly, since an accurate wave-length list of the band lines in this region seems likely to be an important requirement in the near future, consequent upon the extension of the ultra-violet solar spectrum beyond the ozone limit. The latter point is emphasized by Babcock's identification in the solar spectrum of part of the Schumann–Runge system in the 3000–4000 A. region[4].

For these reasons it appeared to us that the bands below 2500 A. might be better obtained by absorption in the heated gas. Earlier work by Füchtbauer and Holm[5], who studied the absorption spectrum of oxygen heated to about 1,000° C., led to the identification, and subsequent rotational analysis by Ossenbrüggen[6], of the following bands in the 2000–2200 A. region: $v'' = 2$, $v' = 5$; $v'' = 3$, $v' = 5$ to 8; $v'' = 4$, $v' = 5$ to 8; $v'' = 5$, $v' = 5$ to 7.

In the experiments now reported, a slow current of oxygen was maintained in an alumina tube, which was heated to near its softening point ($\sim$ 1,900° C.) by an oxy-hydrogen torch. Exposures were made on an $E1$ spectrograph, a hydrogen tube providing the background continuum.

The plates (Ilford $Q1$) show band structure well resolved and in good intensity over the region from 2500 A. to the instrumental cut-off at about 2125 A. The following bands can be picked out by inspection and comparison with the previous emission pictures[2]: (2,6), (3,5), (3,6), (3,7), (4,5), (5,4), (5,5), (6,5). The last three of these were previously measured by Ossenbrüggen; but there appears to be a development on our plates of rotational lines to considerably higher J-values. In addition, there remains a good deal of complex rotational structure, which cannot be assigned to particular bands without measurement; it is to be anticipated that unidentified bands such as (4,4), (4,6) are present.

The results of the measurements will be published later, including, if possible, a wave-length list of all lines observed in emission and/or absorption from 2125 A. to 3200 A. It would seem desirable for completeness that the bands obtained by Füchtbauer and Holm[5] should be re-measured, as the measurements were based on Eder's copper-spark standards, which were later shown by Shenstone to be in error by as much as 0·1 A.

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Sensitivity of Ants to Polarized Light

The work of von Frisch[1] has shown that the honeybee is sensitive to the plane, and possibly to the degree, of polarization of light. Von Frisch himself suggests that some old observations made by Santschi[2] on the homing of ants could be interpreted as suggesting a similar sensitivity. Santschi's experiments, done during summer evenings in the Tunisian desert, showed that some individuals (notably of the genera *Cataglyphis* and *Monomorium*), when returning to their nests, were able to continue in the correct direction although surrounded by a tubular screen of black board. This screen, 50 cm. in diameter and 25 cm. high, restricted the field of view to an arc of sky subtending an angle of 90° at the ant: the sun was excluded by a further screen when necessary. When a flat, horizontal screen was substituted for the tube, the orientation of the ants was disturbed. These experiments have remained almost unnoticed and, unless one accepts Santschi's own theory of sidereal orientation, apparently uninterpreted.

During the late summer of 1949 the problem was investigated in three ways. (1) Santschi's experiments were repeated. The work was done in the flat water-meadows adjoining the River Cherwell, and all the results given below were obtained during the evening under a clear blue sky. The species used was *Myrmica lævinodis* (Nyl.). The tubular screen was 25 cm. in diameter and 30 cm. high, the corresponding arc of sky subtending an angle of 67°. Santschi's observations were largely confirmed. Of the ants studied, 22 per cent were immediately disturbed when the screen was placed in position, 58 per cent set off or continued in the correct direction toward their nest, and of the remaining 20 per cent half took the correct direction when the screen was removed. Further experiments are being undertaken to investigate the effect of other weather conditions, the position of the sun and the use of 'Polaroid' screens.

(2) A laboratory investigation of the sensitivity of *Myrmica ruginodis* (Nyl.) to plane-polarized light was made. A slightly divergent beam of light was thrown vertically downwards on to a flat, horizontal surface. The beam, which was circular in section, passed through a sheet of 'Polaroid C' mounted between two glass plates. The 'Polaroid' disk could be rotated about its vertical axis without visibly disturbing the beam. In the control experiments, the 'Polaroid' was replaced by a sheet of ordinary glass. Under these control conditions, an ant, placed on the flat surface in the beam of light, wandered about, seldom walking for more than 4 cm. in any one direction. Rotation of the glass had no apparent effect upon the movements of the ant. When the 'Polaroid' was present, however, an ant would eventually set off in a straight line, and would continue in the same direction for 10–20 cm. Hence it appears that the ants are able to orientate themselves to a dorsal beam of plane-polarized light, but not to one of ordinary light.

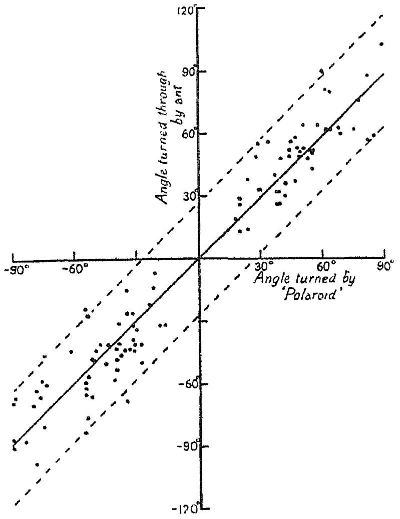
If, however, after the ant had travelled about 5 cm., the 'Polaroid' was rotated, the movement of the ant was disturbed; it either stopped temporarily and then wandered short distances at random before setting off in another, unpredictable direction, or, smoothly changing direction, set off in another straight line without other apparent disturbance. Four such changes were recorded with each ant.

Number of 'runs' made	343
Number with smooth change of direction	118

Of the second group, only thirteen readings showed an ant turning in the opposite direction (clockwise or anticlockwise) to the turning of the 'Polaroid'. The remaining 105 readings were plotted on a graph of angle ant turned/angle 'Polaroid' turned (A/P). A scatter diagram was obtained. The calculated regression of A on P (assuming uniform variance) is

$$A = 0{\cdot}1715 + 0{\cdot}9808P,$$

which is not significantly different from $A = P$. This implies that the ants maintain a constant angle of orientation relative to the plane of polarization of the light. Confidence lines were calculated, between which 95 per cent of the points fall: they are shown as broken lines on the graph. They lie 27° above and below the regression line, and this angle may be an indication of the possible accuracy of



orientation. The angle between the axes of adjacent ommatidia is about 8°.

(3) The optical system of the ant's compound eye was examined with reference to polarized light. The results are complex and merit a discussion too long to be included here.

It seems reasonable to suppose that the above results demonstrate both the sensitivity of ants to the plane of polarization of light and their ability to orientate themselves by means of this sensitivity. While neither the mechanism nor the importance of this property in the field is known, it is thought that both the methods and results of the preliminary demonstration may be of interest to workers beyond the rather limited field of ant behaviour.

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Ciliary Feeding Mechanisms in Anuran Larvæ

The feeding mechanism and mode of feeding of tadpoles of *Xenopus lævis* have been described, notably by Bles[1] and by Weisz[2]. These workers agree in postulating a ciliary mechanism; but their accounts of the nature and functioning of this mechanism differ widely. Bles recognized a ciliated pharyngeal groove lying along the outer margin of the branchial chamber on each side as the main food-collecting channel. Weisz, on the other hand, holds that food particles never reach the branchial chambers, and makes no mention of the ciliated paths which lie at their outer margins and converge on the œsophagus. He states that the middle region of the pharyngeal floor (called by him the "pharyngo-branchial tract" and said to be ciliated) is responsible for creating ciliary currents by which food particles pass backwards into the alimentary canal.

Recent work here has shown the earlier account of Bles to be correct. In particular, it has not been found possible to demonstrate the presence of cilia on the pharyngo-branchial tract, though rhythmical movements of this area during gulping may serve to direct incoming food particles into the branchial pouches. On the other hand, the ciliated pharyngeal grooves and their subsidiary channels in the branchial chambers can be demonstrated very convincingly by the use of finely powdered carmine, or colloidal graphite[3], especially the latter. They are easily visible through the transparent wall of the pharynx within a few minutes of adding the material to water in which the tadpoles are living.

The feeding mechanism of these tadpoles has been compared with that of *Amphioxus* and the ammocœte larva of the Cyclostomata. These organisms, however, exemplify ciliary feeding in the fullest sense illustrated by many invertebrates, that is, both the initial feeding current and the local internal collecting currents are created by ciliary action. In the larval *Xenopus*, however, the feeding stream is dependent on the activity of typical masticatory muscles, the action of which sustains the continuous gulping movements so characteristic of these tadpoles. The ciliary feeding of *Xenopus* larvæ thus combines a ciliary mechanism for food collection and subsequent transportation of a type commonly found in invertebrates or sedentary forms with a masticatory mode of ingestion characteristic of active Gnathostomata. The ciliary part of this apparatus would appear to be an adaptation for microphagy, and may be correlated with absence of peristalsis in the œsophagus. The larval stomach is modified for packing the thin mucous strings charged with food, and seems to have no obvious digestive function. No food particles are liberated in it from the mucus.

Barrington[4], after studying the development and histology of the stomach of larvæ of *Rana temporaria* and *Bufo bufo*, suggested feeding in Anuran tadpoles is fundamentally microphagous. Preliminary experiments with the tadpoles of these two forms show that their feeding mechanisms are essentially similar to that of *Xenopus*. The pharynx is, of course, relatively smaller and less specialized, and 'gulping' is much more rapid; but the particles liberated by the buccal rasp, and particles in suspension in the water, enter the mouth by the gulping activity of the masticatory muscles, and are conveyed to the œsophagus in mucus by ciliary action. As in *Xenopus* larvæ, the stomach serves to pack the mucous strings. Particles of colloidal graphite in the size-range 0·2–2·0 μ are efficiently extracted from water by both these tadpoles, and appear embedded in mucous strings in pharynx, œsophagus, and stomach within a few minutes of the tadpoles being placed in the suspension. Moreover, tadpoles of *R. temporaria* and *B. bufo* have been successfully reared through metamorphosis on a diet of particles of dried liver which would pass through a 200-mesh-per-inch sieve. It may also be noted that Kratochwill[5] has described a ciliary food-collecting mechanism in the larvæ of *Rana agilis*.

I am indebted to Messrs. Acheson Colloids, Ltd., of London, S.W.1, for a supply of 'Aquadag' colloidal graphite.

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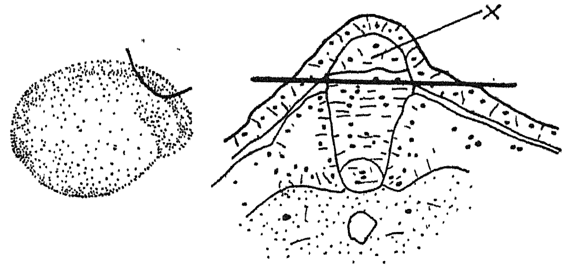
Fate of the Neural Crest in Lampreys

THE favourable nature of amphibian material has permitted the unequivocal demonstration, by both histological[1,2] and experimental[3,4] techniques, of the neural crest origin of most of the splanchnocranium and of the anterior portion of the trabeculæ cranii in these animals. In no other vertebrates is the position so clear; but in selachians[5] and birds[6] a similar origin has been claimed for the visceral bars as a result of studies of normal developmental stages. In cyclostomes the fate of the neural crest and the origin of the head skeleton is of particular interest in view of the doubt cast by Balfour on the homology of the visceral skeleton of lampreys with that of gnathostomes, and the suggestion of Sewertzoff and of de Beer[7] that the 'trabeculæ cranii' of these animals are not visceral elements but are more properly regarded as anterior parachordals.

Study of the normal development of *Lampetra* has led to conflicting opinions on the origin of its branchial skeleton and 'trabeculæ'. Koltzoff[8] and Damas[9] agree that the branchial basket is of ectomesenchymal origin, while Hatta[10] regarded it as derived from mesodermal mesenchyme. Koltzoff[8] and Johnels[11] believe the 'trabeculæ' to be derived from the sclerotome of the anterior head segments, whereas Damas[9] holds that they are of ectomesenchymal origin. These differences reflect the difficulties of the material as an object for histological study. *Intra-vitam* staining is particularly difficult on lamprey eggs, and it is doubtful if the techniques at present in common use would succeed in marking the cell groups involved over the long period necessary to obtain decisive results. There remains the possibility of extirpating the neural crest and examining the larvæ for deficiencies as a preliminary to the investigation of other possible sources of ectomesenchyme.



The extent of the tissue removed in a typical operation. Neural crest is indicated by *X*

This I have been able to do on a small series of embryos of *Lampetra planeri*. Embryos at, or a little beyond, the stage at which they possess three somites suffered the removal of portions of the head neural crest and possibly some of the dorsal part of the medullary cord as well (see figure). Different regions were extirpated in different embryos, but in all cases the removal of tissue was meant to be bilateral in the affected region. Of some sixty experimental animals, fifteen survived long enough (24–26 days, 6·8–7·2 mm. in length) to provide clear evidence of any deficiency in the primary visceral skeleton or in the 'trabeculæ'.

Five of these animals showed no certain deviations from the normal, and it must be presumed that the well-known capacity of the head neural crest in Amphibia to regulate after incomplete removal is shared by that of the lamprey. In the other ten animals there were marked deficiencies, unilateral or bilateral, in one or more of all the cranial ganglia (profundus, trigeminus, facialis, glossopharyngeus and vagus). The first spinal dorsal root ganglion was similarly affected in some cases. In contradistinction to the findings of Stone[3] in Amphibia, the deficiencies in the cranial ganglia were very marked, and in some instances involving the facialis and vagus there was almost complete absence of the ganglion on one side of the animal. The truncus epibranchialis of the vagus, which is generally thought to be of placodal origin, was not affected.

The visceral skeleton, which is represented in larvæ of this age by chondrified bars supporting only rudimentary hypo- and epitrematic elements, showed no deficiencies in any of the animals, even where the ganglion of the corresponding segment was almost completely lacking. Similarly, the 'trabeculæ' were in no case abnormal, even in the three animals which showed deficiencies in the profundus, and the one which had both a defective profundus and trigeminus.

It cannot be said that these results support Hatta's view of the mesodermal origin of the head skeleton. Not only is the material too limited for decision; but more particularly there are good reasons for believing that important sources of ectomesenchyme other than the neural crest exist in the lamprey[9]. They do, however, give confidence in the suitability of the experimental method for solving the problem. It is proposed to continue this work on a larger material, and on other sites of ectomesenchyme formation, during the next breeding season.

I am deeply indebted to Mr. A. R. Hockley, Dr. P. Ford and Mr. M. Abercrombie for help during the course of the investigation.

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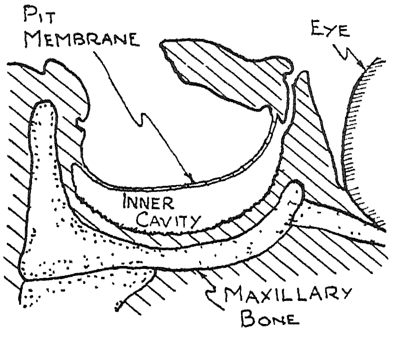
Function and Operation of the Facial Pit of the Pit Vipers

Noble and Schmidt[1] have shown that the facial pit of the pit vipers (Crotalinæ) is a sensory organ enabling the snakes to detect warm-blooded animals in absolute darkness. Their work indicates that this organ senses the radiation from the warm-blooded animals.

The accompanying sketch of the pit from Dr. W. Gardner Lynn's report[2] shows so striking a similarity to a pneumatic radiant-energy detector[3] that one is led to believe that the pit operates in somewhat the same manner; namely, the inner cavity is heated by the radiation and the air in it expands, deflecting the pit membrane. The ultimate branches of the nerves



supplying the pit are distributed in the pit membrane and respond to this deflexion. This interior cavity communicates with the exterior through a small opening near the eye surrounded by a sphincter muscle, and this channel serves as a 'leak' tube in which the rate of flow can be controlled by the sphincter muscle.

Noble and Schmidt have shown that the pit can also sense gusts of air and the motion of cold objects. This can be explained by observing that the motion causes a motion of the air, which in turn can cause a deflexion of the membrane. It is also interesting to note that the surface of the interior cavity is very scalloped, thus making this surface a more efficient absorber of radiation. The membrane is guarded against damage from mechanical sources by being set in a recess (the pit) and is guarded against damage by strong radiation sources and warm environments by the ability of the sphincter muscle to open and close the 'leak' tube.

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A Dispersion of Mosquitoes by Wind

ON the nights of July 28 and August 25, 1942, there were mass migrations of mosquitoes into the camps of the Eighth Army in the Western Desert of Egypt. They became abundant in all tents and vehicles over an area of not less than 75 square miles. They then became scarcer and disappeared after three or four days, when no further specimen could be found.

On July 29 an inspection of the eaves of tents showed some dozens of mosquitoes at rest in each tent, a large majority being *Anopheles pharoensis*. Of 14 specimens collected, 11 were females of this species and 3 were *Culex* sp. (2♂, 1♀). The *Anopheles*, which were in fresh condition, contained partly digested blood, having fed before daybreak on the men in camp. Most men had been awakened by the biting mosquitoes. On August 16 several cases of pyrexia were passed through the writer's Light Field Ambulance; but as the unit had no facilities for laboratory diagnosis it was not possible to say if they were malarious. Barber and Rice[1] showed that *A. pharoensis* is a natural vector in Egypt.

The nearest possible breeding place of these swarms was the swamp near Alexandria called Mallahet Maryut, beginning about 18–28 miles north-east of the area of known invasion. A tour of the camps in this area showed that the mosquitoes were abundant in them all, and doubtless they extended still farther to the south and west.

Both migrations occurred at full moon; indeed, at the time of the second there was an eclipse. A guard on night duty on July 28 said there were no mosquitoes in the early part of the night: they arrived between 2 and 3 a.m., "coming in a cloud of vapour from the north, which looked like a dust storm by moonlight". Strong north-east winds blew on both nights. I am certain that the swarms were wind-borne, since not even large troop movements (of which none was in evidence) could have accounted for the sudden arrival of millions of mosquitoes in the static camps.

The phenomenon supports an observation by Kirkpatrick[2] which has been discounted by later writers. He stated in 1925: "I have myself taken *Anopheles pharoensis* in the Eastern Desert of Egypt almost midway between Cairo and the Gulf of Suez, 35 miles from the Nile valley and some 45 miles from the nearest possible breeding places to the north-west in the direction of the prevalent wind".

It was after this that Sergent *et al.*[3] contested "the popular belief that mosquitoes are carried long distances by wind". Eyles[4], in a recent review of the dispersion habits of Anophelines, gives 5·6 miles as the longest known flight-range of *A. pharoensis*, referring to Kirkpatrick's paper only in general terms; and De Meillon[5], describing the bionomics of the Anophelini of Africa, does not mention flights of this order by *A. pharoensis* nor, I believe, by any other species. The longest flights mentioned by Eyles[4] for any *Anopheles* are 19 miles for a seasonal flight of *A. gigas* and 15·5 miles for *A. pulcherrimus*. Reference to Manson and Ramsay[6] shows that in the case of *A. gigas* the evidence was inconclusive.

Another interesting feature of the Egyptian migrations was their occurrence each time at full moon. Another record of mosquito migrations at full moon is given by Rees[7] for *Aedes dorsalis*, over a distance of two miles at Salt Lake City. As the Egyptian migrations occurred many weeks before the end of the dry summer, they can scarcely have been prehibernation flights of the kind studied by Kligler[8] in *Anopheles sacharovi*. In any event, none of the *A. pharoensis* appeared to contain a developed fat body. If they were not caught involuntarily in an air current (and the fact that the swarms were mixed may point to this explanation), they may be subject to a distinct type of biological dispersion depending on the lunar cycle.

Whatever the cause, is it not possible that one or more species has in the past reached such a place as the Siwa Oasis, where Barber and Rice[1] took *A. sergenti*, *A. multicolor* and *A. pharoensis*, on a wind which could travel two hundred miles across the desert in one night?

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Œdema of the Bowel in Pigs

This obscure condition, which was first described by Shanks[1] and Lamont[2], has now become a major hazard to store-pigs in the whole of Ireland. It is now apparently causing serious concern in Great Britain. Repeated attempts at transmission by the staff at this laboratory have so far failed. A few months ago we came across a reference by Kurnick[3] to a condition in the human characterized by œdema which was thought to be due to a protein deficiency. In July 1949, Dr. Mitchell, Dominion Pathologist, Canada, visited this laboratory, and he directed our attention to the work carried out by Gwatkin and his associates[4] on the protein fraction in the diet of the pig.

We have carried out a series of serum protein estimations in the blood of the pig from litters in which deaths from gut œdema have been occurring. The estimations have been made by the biuret method using the Lovibond comparator.

Forty-four such blood samples have so far been examined, as well as a number of controls from litters with no history of gut œdema. Thirty-three control blood samples gave an average figure for serum protein of 6·64 gm. per cent. The highest figure was 8 gm. and the lowest was 5·5 gm. per cent. Forty-four samples of serum from 'in contact' and affected pigs ranged from 2·5 gm. per cent to 7·0 gm. per cent, with an average figure of 4·63 gm. per cent over all the samples.

It is emphasized that the vast majority of the latter group did not show any symptoms of the disease, even though the serum protein-level was much below the level of the control group. None of the sick pigs examined so far had a serum protein-level above 5 gm. per cent, though some of the 'in contact' apparently normal pigs in this group had also serum protein-levels of this low order. The preliminary work tends to show that, associated with this condition of gut œdema, there is a well-marked hypoproteinæmia.

The purpose of this note is to direct the attention of other research workers to this observation, which may prove significant in the etiology of this obscure condition.

The assistance given and the interest shown in this work by our technician, Mr. T. Cahil, is gratefully acknowledged.

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Geographical Distribution of the Body-Weight/Body-Surface Ratio

In the course of biometrical work concerning twenty different human samples—the individual figures partly obtained by myself and partly taken from other sources—I have found the following values for the body-weight/body-surface ratio (kgm./m.^{2}):

	Men	Average	σ
72	French workers	37·99	1·93
75	French soldiers	37·88	2·10
107	Italian soldiers (natives of Sicily)	37·43	1·86
37	Albanians	37·05	1·97
70	men from Southern Europe (Mediterranean countries)	36·93	1·75
21	Arabs (Yemen)	36·01	1·47
99	Annamites (French Colonial troops)	36·02	1·30
124	Somalis Darod	35·09	1·78
117	Somalis Rahanoween	34·67	1·78
87	Somalis Hawiyah (Haweeah)	34·42	1·54
47	Somalis Dir	31·42	1·77
50	Negroes Gobaween (Somalia)	34·71	1·67
107	Otomies (Mexico)	34·98	1·83
19	Berbers (Giado)	35·41	1·75
25	Daouad (Fezzan, North African desert)	33·92	1·20
40	Andamanese	32·42	1·71
	Women		
54	Parisians	35·83	2·68
34	Rahanoween	37·92	2·05
15	Gobaween	37·43	1·53
36	Andamanese	33·35	2·32

When we compare geographically distant groups, the differences are statistically significant. For example, if we compare the lowest European average (36·93) and the highest non-European average (36·02), we find that the ratio of difference to standard error of difference is 3·6 ; the same ratio is 5·0 if we compare French workers with Arabs, and 10·3 if we compare the same workers with Darod Somalis.

There is obviously a decline of the value of the ratio as we proceed from temperate to tropical regions. Of course, ratios do not follow exactly either latitudes or isotherms—such would be indeed surprising—but the general tendency is clear. Perhaps, even in Europe there is some decrease from north to south. The last of the 'Europoid' samples (Yemenite Arabs) is apparently outside the European range, the lower limit of which, for the adult male, seems to be approximately 37·00. The Arabs have practically the same ratio as the Annamites (natives of Tonkin, northern Indo-China, a country with a relatively fair tropical climate). The decrease is more evident if we compare European values with those of other samples from desert or tropical surroundings.

Now, the ratio weight/surface plays a part in the regulation of body-heat. In a hot climate a relative deficiency of body-mass—or relative excess of body-surface—is an advantage. Possibly climatic agencies operated selectively with a convergent result ; but, if so, it would be a peculiar kind of convergency, with radically divergent anatomical implications, as the same biologically important ratio is attained by the extreme dolichomorphs (Somalis) and the extreme brachymorphs (Otomis).

If this be true, we must admit at the same time the interference of an independent sexual factor, for the position is not the same with women. Unfortunately, the latter are represented only by four samples (I lost during the War the data concerning Otomi women I measured in 1936). Nevertheless, there appears to be a racial as well as a sexual difference : the average ratio for French women is definitely lower than the ratio for any European male sample ; the ratio for 'tropical' women is definitely higher than the ratio for men of the same stock. It must be remembered that, in women, heat regulation does not work in exactly the same way as in men.

A full account of these findings, together with a detailed anthropometrical body-build analysis, of eleven kinds of males and three kinds of females, will be published in *l'Anthropologie*.

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Oct. 3.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Saturday, February 18

Institution of Mechanical Engineers, Graduates' Section (at Storey's Gate, St. James's Park, London, S.W.1), at 3 p.m.—Sir Harry Ricardo, F.R.S.: "Combustion in Diesel Engines".

Monday, February 20

British Society for the History of Science, Philosophy of Science Group (in the Joint Staff Common Room, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. M. D. H. Strauss. "Quantum Theory and Logic".

Manchester Literary and Philosophical Society (in the Reynolds Hall, College of Technology, Manchester), at 5.30 p.m.—Prof. Max Born, F.R.S.: "Physics and Metaphysics" (Joule Memorial Lecture).*

University of London (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. H. C. Darby: "Domesday Geography" (Inaugural Lecture).*

Institution of Electrical Engineers, London Students Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 7 p.m.—Prof. E. B. Moullin: Presidential Address.

Institution of the Rubber Industry, Liverpool Section (joint meeting with the Local Section of the Royal Institute of Chemistry, at Common Hall, Hackins Hey, Liverpool), at 7 p.m.—Mr. P. G. Croft-White: "Petroleum Products for the Rubber Industry".

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 8 p.m.—Mr. J. M. Waldram: "Public Lighting" (Cantor Lectures). (Further Lectures on February 27 and March 6.)

Royal Geographical Society (at 1 Kensington Gore, London, S.W.7), at 8.15 p.m.—Mr. Peter Lloyd: "British Expedition to Nepal".

Tuesday, February 21

British Psychological Society, Industrial Section (in Room 105, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 1 p.m.—Dr. D. W. McElwain. "Researches in Social Psychology in the University of Melbourne".

Royal Anthropological Institute (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Dr. J. D'A. Waechter: "Preliminary Excavations at Gorham's Cave, Gibraltar".

Institution of Electrical Engineers, Measurements Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Electrical Methods of *p*H Measurement" (to be opened by Mr. G. I. Hitchcox and Mr. G. R. Taylor).

University of London (at King's College, Strand, London, W.C.2), at 5.30 p.m.—Prof. J. F. Danielli: "The Preservation of Science and Learning" (Inaugural Lecture) *

Chemical Society, Leeds Section (joint meeting with the University Chemical Society, in the Chemistry Lecture Theatre, The University, Leeds), at 6.30 p.m.—Dr. H. D. Springall: "Some Recent Applications of Dipole-Moment Measurements to Molecular Structure".

Institute of Petroleum, Northern Branch (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Symposium on "The Petroleum Industry as a Career".

Wednesday, February 22

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Mr. Kenneth Holmes: "The Linking of Technical and Art Education".

Royal Meteorological Society (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Mr. J. E. N. Hooper and Mr. A. A. Kippax: "The Bright Band—a Phenomenon associated with Radar Echoes from Falling Rain", to be followed by a Discussion on "Radar Echoes".

Royal Statistical Society (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Dr. P. G. Gray and Mr. T. Corlett. "Sampling for the Social Survey".

Institution of Electrical Engineers (joint meeting of the Supply and Utilization Sections, at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. L. Gosland: "The Cost and Efficiency of Earthing on Low- and Medium-Voltage Overhead-Line Systems".

Manchester Literary and Philosophical Society, Chemical Section (at the Portico Library, Mosley Street, Manchester), at [illegible].45 p.m.—Dr. E. G. Edwards: "Some Aspects of Freedom for Science".

Plastics Institute, London and District Section (at the Waldorf Hotel, Aldwych, London, W.C.2), at 6.30 p.m.—Mr. A. A. Tomkins: "Advances in Moulding Technique".

Royal Statistical Society, Birmingham and District Group of the Industrial Applications Section (at the Chamber of Commerce, 95 New Street, Birmingham), at 6.30 p.m.—Mr. D. J. Desmond: "Specifications and Tolerances". (To be repeated at 6.30 p.m. at the Chemical Industries Club, 18 Lovain Place, Newcastle-upon-Tyne, on Wednesday, April 19.)

Institution of the Rubber Industry, Leicester Section (at the Technical College, Leicester), at 7 p.m.—Mr. W. P. Fletcher: "Technical Aspects of High Polymers".

Society for Visiting Scientists (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Discussion on "The Planning of Agricultural Research in Great Britain" (Speakers: Dr. W. K. Slater, Dr. C. D. Darlington, F.R.S., Prof. S. Zuckerman, F.R.S.)

Thursday, February 23

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Sir Arthur Fleming and others: "The Research Laboratories of Associated Electrical Industries, Limited".

University of London (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 4.45 p.m.—Dr. Tudor S. G. Jones: "The Peptide Bond in Biochemistry".* (Further Lectures on March 2 and 9.)

Linnean Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Discussion on "Morphology and Fine Structure" (to be opened by Dr. C. F. A. Pantin, F.R.S., Dr. J. R. Baker, Dr. L. E. R. Picken and Mr. J. R. G. Bradfield).

Chemical Society, Nottingham Section (joint meeting with the University Chemical Society, in the Chemistry Lecture Theatre, The University, Nottingham), at 6.30 p.m.—Prof. A. R. Todd F.R.S. "Synthesis in the Nucleotide Field".

Royal Aeronautical Society, Graduate and Student Section (at 4 Hamilton Place, London, W.1), at 7 30 p.m.—Mr. W. R. Shapey and Mr. J. Rivers: "Some Problems of Heat Transfer".

University of London (at Wye College, Wye, near Ashford, Kent), at 8.15 p m.—Prof. G. W. Robinson, F.R.S.. "Soils and Crops".*

Friday, February 24

Institution of Mechanical Engineers (joint meeting with the Institution of Electrical Engineers, at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. J. F. Field: "The Application of Gas Turbine Technique to Steam Power".

North-East Coast Institution of Engineers and Shipbuilders (at the Mining Institute, Neville Hall, Newcastle-upon-Tyne), at 6.15 p.m.—Mr. A. Emerson: "A Review of Ship Model Data".

Oil and Colour Chemists Association, Manchester Section (in the Chemistry Lecture Theatre, The University, Oxford Road, Manchester), at 6.30 p.m.—Prof M. G. Evans, F.R.S.: "The Design of Experiment". (All members of the Manchester Federation of Scientific Societies are invited.)

Television Society (at the Cinema Exhibitors' Association, 164 Shaftesbury Avenue, London, W.C.2), at 7 p.m.—Demonstration and Discussion on "Television Aids—Polaroid, Lenses, Filters, Lighting, Special Aerials, Interference Suppressors".

Saturday, February 25

British Psychological Society, Education Section (in the Hastings Hall, Tavistock House, Tavistock Square, London, W.C.1), at 2.30 p.m.—Mr. C. D. Butler. "The Development of Techniques for Testing Social Attitudes".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Head of the Department of Physiology, and a Senior Assistant—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London, S.W.3 (February 25).

Lecturer in Biology—The Principal, Acton Technical College, High Street, Acton, London, W.3 (February 25).

Lecturer in Mathematics—The Clerk to the Governors, South-East Essex Technical College and School of Art, Longbridge Road, Dagenham (February 25).

Lecturer in the Department of Science and Related Mathematics—The Principal, Aston Technical College, Whitehead Road, Birmingham 6 (February 25).

Lecturer in Human Physiology, and a Lecturer in Experimental Physiology—The Registrar, The University, Manchester 13 (March 3).

Chair of Chemistry—The Principal, Heriot-Watt College, Edinburgh (March 6).

Lecturer in the Department of Civil Engineering—The Secretary and Registrar, The University, Bristol (March 6).

Metallurgists in a Ministry of Supply Research and Development Establishment in London, for work on refractories, electrodeposition and for analytical work—The Technical and Scientific Register (K), York House, Kingsway, London, W C.2, quoting F.77/50A (March 7).

Chemical Engineers (Principal Scientific Officer and Senior Scientific Officer grades) at the Atomic Energy Research Establishment, Harwell, for duties in research groups dealing with pilot plant development of the wide range of chemical processes associated with the development of atomic energy and for fundamental research in the unit operations involved—The Secretary, Civil Service Commission, Scientific Branch, 7th Floor, Trinidad House, Old Burlington Street, London, W.1, quoting No. 2951 (March 7).

Senior Scientific Officer and Senior Experimental Officer at a Ministry of Supply Establishment in South Wales, for laboratory work on development of methods of fabricating and testing special ceramic bodies and development of new apparatus for this purpose with responsibility for setting up a field station for routine production of specialized ceramics—The Secretary, Civil Service Commission, 7th Floor, Trinidad House, Old Burlington Street, London, W.1, quoting No. 2953 (March 7).

Honours Graduate in Physics or Chemistry, for a research post in connexion with the Electrochemical Laboratory, for the study of electrode processes—The Registrar, King's College, Newcastle-upon-Tyne (March 11).

Experimental Officer or Assistant Experimental Officer (male) in the Pomology Section, in connexion with the research programme on soil management in fruit plantations—The Secretary, East Malling Research Station, East Malling, Maidstone, Kent (March 17).

Chemists (Scientific Officer class) (with good honours degree or equivalent in Chemistry) under the Ministry of Supply, in London: Physical Chemist for development work connected with use of novel materials for metallurgical work, a Physical and Inorganic Chemist preferably with experience in quantitative estimation of radioactive materials, and a Physical Chemist with good grounding in modern physical methods and with bent for mathematical work—The Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.90/50A (March 18).

SCIENTIFIC OFFICERS (2) (Ref. F.92/50A) with good honours degree or equivalent in Chemical Engineering or Chemistry, with post-graduate academic training in chemical engineering, an INSTRUMENT ENGINEER (Experimental Officer class) (Ref. D.33/50A) with Higher National Certificate or equivalent in Electrical Engineering, with sound knowledge of Electronics, CHEMICAL ENGINEERS (3, Experimental Officer class) (Ref 92/50A) with Higher National Certificate or equivalent in Chemistry, with experience in preparative work employing technical or large-scale equipment, an ORGANIC CHEMIST (Experimental Officer class) (Ref. F.91/50A) with Higher National Certificate or equivalent in Chemistry, with ability to carry out organic preparative work, at a Ministry of Supply Research and Development Establishment in Lancashire—The Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (March 18).

PHYSICISTS (Scientific Officer grade) at a Ministry of Supply Research and Development Establishment near London: (*a*) ELECTRONIC PHYSICIST for work on application of electronic methods to photography of detonation phenomena, (*b*) CLASSICAL PHYSICIST for study of experimental results of work on detonation waves, (*c*) THEORETICAL PHYSICIST for work on effect of blast on structures, (*d*) PHYSICIST with wide and varied experimental experience, (*e*) GENERAL PHYSICIST with maths., for experimental work on electrical and optical investigations and mathematical analysis of results, (*f*) PHYSICIST with mathematical ability for work on aerials, (*g*) PHYSICIST and ELECTRONIC ENGINEER for work on electro-optical systems, (*h*) PHYSICIST with maths., to plan and organise experimental work with small team—The Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.21/50A (March 18).

READERSHIP IN PHARMACOLOGY at King's College, London—The Academic Registrar, University of London, Senate House, London, W.C.1 (March 24).

JOHN WILLIAM HUGHES CHAIR OF CIVIL ENGINEERING—The Registrar, The University, Liverpool (March 25).

CHAIR OF METALLURGY in the New South Wales University of Technology—The Agent-General for New South Wales, 56 Strand, London, W.C.2 (April 1).

GRADUATE IN THE PLANT PATHOLOGY DEPARTMENT, for work on fungus diseases of field crops—The Secretary, Rothamsted Experimental Station, Harpenden, Herts (April 17)

COLONIAL LIAISON OFFICER (preferably with an honours degree in Science, and should have had experience of biological research, preferably overseas) at the Pest Infestation Laboratory, Slough—The Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting G.25/50A (April 29).

SUSAN STEBBING STUDENTSHIP for post-graduate work in Philosophy—The Principal, Bedford College for Women, Regent's Park, London, N.W.1 (May 1).

NUFFIELD RESEARCH STUDENTSHIPS AND FELLOWSHIPS for experimental and theoretical research in Nuclear Physics—The Professor of Natural Philosophy, The University, Glasgow, W.2 (May 1).

ASSISTANT DUST SUPPRESSION OFFICER—The Divisional Establishment Officer, National Coal Board, North-Western Division, 47 Peter Street, Manchester 2.

ASSISTANT MANAGER (Shift Control) to be responsible for implementing policy and co-ordinating activities during closed hours in a large chemical factory in the Division of Atomic Energy (Production), Windscale Works, Sellafield (candidates must have an honours degree in Chemistry or Engineering, or associateship of the R.I.C., or corporate membership of I.M.E., I.E.E., or I.C.E.)—The Administrative Branch, Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

ASSISTANT WORKS MANAGER (with an honours degree in Chemistry or associateship of the R.I.C. or equivalent qualification, with several years' experience of chemical plant operation in industrial processes involving toxic hazards) to be responsible to the Works Manager for the operation of the plant in a large chemical factory—The Administrative Branch, Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

DIRECTOR OF PRODUCTION (with an honours degree in Chemistry, Physics or Engineering, long experience in the management of heavy chemical or similar production plants, and must understand modern methods of control by cost and technical figures, the safe operation of processes handling toxic materials, etc.)—The Administrative Branch, Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

GRADUATE LECTURER IN BIOLOGY—The Principal, North Staffordshire Technical College, Stoke-on-Trent.

HEAD OF THE MATHEMATICS DEPARTMENT—The Registrar, Technical College, Sunderland.

LECTURER IN PURE AND APPLIED PHYSICS—The Registrar, College of Technology and Commerce, The Newarke, Leicester.

ORGANIC CHEMIST with some research experience, and a PHYSICAL CHEMIST with some research experience—The Secretary, British Rayon Research Association, Barton Dock Road, Urmston, Manchester.

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FREEDOM AND RESPONSIBILITY IN SCIENCE

AT least three factors in recent months have raised anew the problem of the conditions of scientific work and particularly freedom of investigation and of publication. Sir Hartley Shawcross has testified to the vital importance of a free Press, but even his reassuring statement on behalf of the Government does not entirely remove concern on this point. Moreover, in view of the complexity of most public affairs to-day and the growing extent to which technical and scientific factors determine the success or failure of policy and plans, the need for independent and impartial criticism was never greater.

A large part of the responsibility for such criticism must fall on men of science and technologists; but, if they are to discharge that trust, they must not only be assured of a vehicle of expression but also of full information on which to base sound opinion. It is because the means of forming such opinion are restricted or denied that there is widespread uneasiness to-day. The public corporations are an example, and if the groundnut scheme of the Overseas Food Corporation provides the worst example, it is only true to type. Atomic energy is a further example with which the Atomic Scientists Association in particular has been concerned.

Concern has been freely expressed in Great Britain about the possible effects of secrecy in nuclear research on the advancement of science in other fields, although no such situation has yet arisen comparable with that which has followed the inclusion in the 1950 Independent Offices Appropriation Act passed by Congress last August of the provision for loyalty and security investigation of all Atomic Energy Commission 'fellows'. Subsequent discussions within the U.S. National Academy of Sciences and the National Research Council revealed almost unanimous opposition to the application of clearance procedures to those working in fields which are not secret. The Academy accordingly recommended that the National Research Council should not accept the responsibility for administering the altered fellowship programme, and urged the Atomic Energy Commission to take all proper steps to see that these restrictive provisions are omitted from future legislation. The Atomic Energy Commission believes that any fellowship programme affecting a substantial number of students training in broad and established fields of science should be administered by a scientific or educational organisation. Further, it would be extremely difficult to administer an effective fellowship programme which did not receive the full support of the scientific community. Under these conditions, the Atomic Energy Commission has drastically reduced its fellowship programme. No new pre-doctoral fellowships will be offered for 1950–51, and post-doctoral fellowships will be limited to work requiring secret information. It is expected that about 75 new awards will be offered and about 175 renewals granted as against a present total of 421 fellows, of whom only 30 are engaged in secret work.

That position is sufficient to illustrate the way in which secrecy requirements may affect the conduct of research. It is well known that, with the passing by Congress of the provision in question, there was a marked falling off in the quality of applicants for fellowships. In Australia, too, Dr. I. W. Wark has expressed concern that acceptance by the universities of contracts for secret defence research may endanger their independence; while others besides Sir David Rivett are concerned lest the new status of the Commonwealth Scientific and Industrial Research Organisation should prove detrimental to the establishment of the atmosphere in which scientific research flourishes.

The third source of concern is provided by the genetics conflict in the Soviet Union. That the Russian Government has attacked the very intellectual liberties which make scientific research possible is sufficiently serious; but for a major nation to over-ride, even in a particular field such as genetics, the basic scientific appeal to facts by ideological considerations does not mean simply, as Dr. Julian Huxley has pointed out, the repudiation of certain basic elements of scientific method; it means also the repudiation of the universal and supra-national character of science. Nor can we any longer believe that this threat to the freedom and unity of science is confined to Russian territory.

No matter which of these three factors has stimulated our interest, the freedom of science is no isolated question. It is one facet of the wider problem of the preservation of a free society. Freedom of utterance and publication for the man of science is an essential part, for example, of that larger question of freedom of the Press, of the right to know and to utter freely and to expose threats to civil liberty or the general welfare, whether or not they are due to encroachments by the central executive or to errors of judgment by public or private bodies. So, too, the question of secrecy cannot be resolved save as we take a clear and realistic view of the requirements of national defence and security as well as of the conditions which favour scientific research. There is required the positive view of security which Sir David Rivett has emphasized; we must look primarily to achievement and not to negative restraint, and we must seek to formulate our conception of the freedom of science in the context not only of responsibility for creative work, but also of responsibility for the well-being of a society in which scientific effort is an essential element.

From this point of view it is important that scientific workers generally should consider more fully the wider issues raised by this question of human rights, whether in the specific form in which it is presented by the clash over the civil liberties of scientific men in the United States in regard to the Atomic Energy Commission fellowships, or by the essays on the scientific aspects of human rights contributed to the symposium published recently by the United Nations Educational, Scientific and Cultural Organisation. In this connexion the conclusions and recommendations of the special committee appointed by the Council of the American Association for the Advancement of Science deserve attention, although they were limited to three main questions: restrictions on research and scientific information; measures to assure the personal reliability of scientific men having access to confidential data; and inquiries relating to the 'loyalty' of scientific workers in Federal employment. The Committee nevertheless seized the opportunity to point out that secrecy is damaging to both science and democracy and fully endorsed an important passage in the third volume of the Report on Science and Public Policy (see *Nature*, **162**, 673; 1948), dealing with Administration for Research. Discussing the three key questions of planning and research, professional compatibilities and scientific freedom and national security, the Steelman Committee said: "Strict military security in the narrow sense is not entirely consistent with the broader requirements of national security. To be secure as a Nation we must maintain a climate favourable to the full flowering of free inquiry. However important secrecy about military weapons may be, the fundamental discoveries of researchers must circulate freely to have beneficial effect." In its first volume the Committee urged that, in the long run, national security depends far more upon the nation's total scientific potential than upon any other consideration.

In the view of the Steelman Committee, with which the Committee on Civil Liberties concurs, security regulations should be applied only when strictly necessary, and should then be limited t specific instruments, machines or processes. It when they are left vague that they may be constru to cover basic principles of fundamental knowled and that is why the view of the defence authori in Australia, for example, gives rise to uneasiness the degree of freedom of fundamental and ap research is governed by the requirements of na defence and does not depend on specific p which can be clearly defined, no continuous of restrictions on either publication or the pros of research can avoid being detrimental particu in discouraging the most creative and fertile mi from working in such fields.

Assuming, however, that the area of secrecy been clearly defined—and at the minimum consist with the requirements of national policy—the C mittee on Civil Liberties for Scientists admits the reliability of those persons to whom these ma are entrusted must be assured. Nevertheless, extremely critical of the present organisation conducting inquiries into the character and attit of the scientific workers affected; not only are t procedural and administrative defects, but als inquiries are applied far too widely. The exce precautions discourage participation in impor research activities closely linked to the nati welfare, and the delays and expense often involve deter qualified persons from entering the atomic energy programme. The Committee rightly observes that work in this field will be shunned by men of ability and pride if they are constantly treated as objects of suspicion and possibly calumny.

Of the Loyalty Order, the Committee is even more critical. This Order is objectionable, in the view of the Committee, because it seeks to determine the employee's loyalty by inquiring into his supposed thoughts and attitudes, which are established in large part by imputing to him the beliefs of his associates. Instead, attention should be focused on his behaviour in overt acts. In so far as the Loyalty Order purports to deal with such matters as espionage, sabotage and disregard of instructions, it is wholly superfluous. Criminal conduct of that character is already subject to administrative disciplinary action under existing law and regulations. The failure to confine the Loyalty Order to matters of objective proof has engendered a feeling of insecurity in public employment, and may be expected to lessen the vigorous intellectual independence which is a prime condition of sound scientific work as it is of an imaginative Civil Service.

These conclusions of the American committee are of profound interest elsewhere. The Committee formulating them was fully aware of the difficulties of the situation and that no easy solution would be found. It put its finger on the defective character of the very concepts which the Loyalty Order expresses, and more than anything else the findings of the Committee demonstrate the need for some fundamental and imaginative thinking on the administrative side if the scientific effort of the nation is not to suffer.

But such fundamental and imaginative thought is demanded of the scientific worker also, and, in his contribution to "Human Rights", R. W. Gerard makes an attempt to indicate how a biological approach could help in the discovery of what human rights in the present situation might be. Such a positive approach is essential, and Mr. Gerard does not merely remind us that such rights are relative to society and that sometimes rights must be abrogated as new ones are demanded. He points to the greater dependence of the individual on the group, and at the same time to the falseness of any doctrine which regards man only as an individual or only as a unit in a group. We cannot escape the duality of man as an individual and as a social unit, and accordingly the extremes of individualism and collectivism, anarchism and totalitarianism, *laissez faire* and absolute economic socialism are untenable.

The biological approach upholds the view that the rights of man involve rights of the individual (or small group) as against other individuals (or groups) or the whole of society, and duties are correspondingly implied; just as, conversely, there are rights—and duties—of the whole or the whole group as against the individual. To work out the implications of freedom of science itself at the national level involves thinking out the implications and relations at the level of the professional association or even at the level of the smaller groups comprised in any such association or working unit. Even at that level, it is possible to think that Mr. Gerard is a little optimistic in thinking that altruism is growing relative to selfishness, and control is being exercised relatively ever more by suasion as compared to force.

Dr. J. M. Burgers recognizes that only by the free and open contest of opinions formed in as many and as diverse minds as possible can we avert the danger that our society will run in directions which will bring an end to all creativeness; but, in his discussion of the dangers which attend the introduction of legal secrecy restrictions into science, the most important point he makes is the duty of the scientific worker to help the public to understand the meaning and importance of scientific findings. That this duty has been imperfectly discharged may well be one reason for the excessive restrictions which Congress has imposed in the United States on work in the atomic energy field. This is all the more important because, as Dr. Burgers notes, there is always risk of misunderstanding and even misuse of every expression of truth, owing to the limitations of the minds which frame such expression.

Nevertheless, for all this qualification, Dr. Burgers's formulation of the duties and rights of creative expression seems at least a little too dogmatic, and scarcely admits of the conditioning which may be required by relations between individuals and smaller and larger groups. His claims for freedom of scientific intercourse and publication, and free access to all published material, are too sweeping; and, like his repudiation of all secrecy restrictions upon scientific research or its publication for competitive purposes, are open to abuse. The question of responsibility is vital but is virtually ignored; although he does insist on the responsibility of the scientific man in the matter of furthering the understanding of the implications of science and the possibilities flowing from the application of science.

The question of responsibility is much more closely examined, however, by Dr. B. J. Bok, himself a member of the Committee on Science and its Social Relations of the International Council of Scientific Unions, in an article on "Freedom of Science and the Universal Declaration of Human Rights" in the *Bulletin of the Atomic Scientists* of August–September. Dr. Bok clearly recognizes the way in which the freedom of science is only one aspect of human freedom in general and depends upon the existence in world opinion of a 'climate' favourable to it. He recognizes, too, that the main danger to the freedom of science in the West is not so much direct attack as insidious and unnoticed encroachments under changing conditions of modern life, and that the first need is unceasing vigilance and the willingness of scientific men to protest vigorously and promptly against all attempts to infringe these freedoms.

Scientific workers can no longer take for granted any particular freedom, whether of investigation, of utterance or of movement, vital as they are to the interplay of minds upon which intellectual advance depends. It is not sufficient for them to protest against infringements of such freedom: they must rather seek to secure the support and understanding of their fellow citizens by making known the reason for their protests, and by showing just how it is that, without freedom, society cannot hope to reap the full benefit of the work of either individuals or of the vast body of existing knowledge. A sense of public responsibility must be available to support their protests.

That is the spirit in which Dr. Bok has formulated a revised personal version of the charter for scientific workers, which attempts to meet some of the criticisms of the draft originally suggested by the Committee on Science and its Social Relations in 1948. Dr. Bok limits the rights he claims for scientific men to three principal ones: the right to participate freely in all activities permitted to the average citizen; the right to obtain general information about the purposes of designed projects; and the right to publish the results of researches and to discuss work in progress with fellow workers, except where these privileges may have to be restricted for socially or ethically justifiable reasons.

These rights, however, should be considered in the light of the obligations which they entail on the scientific man himself, though even so it must be admitted that it would be necessary to give clear meaning to some of the phrases before they could be generally accepted. There may well be a wide field for difference of opinion as to what constitutes socially or ethically justifiable reasons. Again, it may be taken for granted that it is the duty of every scientific man to maintain a spirit of honesty, integrity and co-operation, to promote the development of science in the ways most beneficial to mankind and, so far as possible, to prevent its misuse, to assist in the education of the people and of governments in the aims, methods and spirit of scientific research, to promote international collaboration in science, to work for the preservation of world peace, to contribute towards a spirit of world citizenship and to emphasize and develop the human values associated with science and technology; but not every one could accept without reservation or further definition the obligation which Dr. Bok puts second, namely, to examine searchingly the meaning and purposes of the work he or she is performing, and, when in the employ of others, to inquire into those purposes and to evaluate the moral issues that may be involved. That is a responsibility not lightly to be undertaken, nor easily discharged without detriment to the individual or to science itself. Subject to the qualification that the spirit of honesty, integrity and co-operation is maintained and that the examination is in the mind of the man and not a cloak for prying into extraneous affairs of his employer, whoever that may be, it may come nearer to acceptance than in its original form. The difference, however, appears to be slight, and it is rather in the spirit of Dr. Bok's article that some advance on the original suggestions can be discerned. He focuses attention sharply on the problems that are yet to be solved, and, while he advances no more than tentative suggestions for solving some of them, he displays clearly the challenge which the present situation throws down to all who are concerned with the advance of science and the welfare of mankind. Progress in science will be made in the future, as it has always been, by the free mind, left to its own working; but the conditions under which science is free can only be secured to-day when the goodwill and understanding of the whole community are enlisted in their defence.

MATHEMATICAL BIOPHYSICS

Mathematical Biophysics

By N. Rashevsky. Revised edition. Pp. xxiii + 669. (Chicago: University of Chicago Press; London: Cambridge University Press, 1948.) 7.50 dollars.

About half of this revised edition is reprinted with little change from the first edition of 1938. Some of the remaining chapters appeared in Rashevsky's "Advances and Applications of Mathematical Biology" (1940) and other publications, while the rest are new. As a result, the style is uneven and some of the chapters are out of date. An example of the latter is the treatment of nerve conduction, in which no account is taken of the capacity of the surface membrane.

The first three sections of the book cover the same ground as the first edition. In the first section, Rashevsky develops a theory of the stability, growth and division of cells, which depends on osmosis and the forces due to diffusion fields. The second deals with excitation and conduction in nerve fibres, while in the third he suggests mechanisms by which simple elements in the central nervous system might be combined to do some of the things of which the brain is capable. The fourth section deals with the form and movement of the whole organism and is reminiscent of D'Arcy Thompson's "Growth and Form". It ends with a chapter on "The Organic World as a Whole", in which equations are given (but not solved) governing the course of evolution.

The expressed intention of this book is to "lay the first stone" of "a mathematical biology which would stand in the same relation to experimental biology as mathematical physics stands to experimental physics". Rashevsky also says in the introduction that the mathematical natural sciences "should not be made mere handmaidens of the experimentalist". One can scarcely quarrel with these opinions; but the book loses much of its value, at any rate for the experimentalist, through thus asserting the theorist's independence. Each of Rashevsky's wide range of topics is developed on a single set of assumptions, and in most cases the treatment will be valueless if the assumptions turn out to be wrong. No help is given to the experimenter who may wish to test the assumptions; alternative hypotheses are not developed, and the author does not point out how far the results depend on particular features of the assumptions. There are a fair number of graphs showing agreement between the theoretical formulæ and experimental results obtained by others; but they are not presented in a way which enables one to judge whether they really support the theory. In one case at least (p. 39), totally unjustified conclusions are reached through using a fallacious procedure for curve-fitting.

The book is not easy to read. In each chapter, assumptions and definitions of symbols are introduced piecemeal, and results are usually given only as equations. Hence one cannot even discover what is attempted without reading the chapter from beginning to end. The book does, however, contain much that is interesting and stimulating, particularly in the section on the central nervous system. Most of its faults are the direct result of attempting, over a wide field, a synthesis for which an adequate experimental basis does not yet exist.

A. F. HUXLEY

ANIMALS ON PARADE

The Story of Animal Life

By Dr. Maurice Burton. Vol. 1: The Framework of Animal Life; Invertebrates. Pp. xii+381. Vol. 2: Vertebrates. Pp. viii+423. (London: Elsevier Publishing Co., Ltd., 1949.) 63*s*.

HERE is a survey of the entire animal kingdom, produced and illustrated in a luxurious fashion, and written mainly by Dr. Maurice Burton, deputy keeper of zoology in the British Museum (Natural History) and one of Britain's leading exponents of animal biology. Other zoologists contributed articles under the editorship of Dr. Burton. These include: Dr. W. E. Swinton, Mr. T. H. Savory, Dr. G. Crile, Dr. D. Dilwyn John, Prof. M. W. de Laubenfels, Dr. J. D. Ommaney, Dr. Ben Dawes, Dr. T. Mortensen, Dr. J. P. Harding, Dr. S. M. Manton, Dr. T. E. Snyder, Dr. C. H. Curran, Prof. G. D. Hale Carpenter, Dr. G. Barendrecht, Mr. G. Nixon, Prof. L. Bertin, Dr. C. M. Bogert, Mr. E. G. Turbott, Mr. D. Goodwin, Mr. B. East, Mr. K. W. Kenyon, Mr. W. Van Riper, Dr. W. R. Philipson, Dr. J. E. Hill, Mr. D. Fleay, Lotus and Margery Milne, Prof. W. H. Hodge, Mr. L. W. Walker, Mr. H. W. Nissen and Dr. Ida M. Mellen—an impressive list of names, but then this is an impressive work. The late Mr. W. P. Pycraft left a number of notes which the editor was able to utilize in the preparation of Vol. 2.

The two volumes are packed with photographs, most of them large ones, of a very high standard in art and animal portraiture. For example, the six pictures depicting commensalism and showing a hermit crab moving from one protective shell to another, to be followed soon afterwards by two sea anemones, are nothing short of superb. The close-up photograph of a praying mantis with a wasp gripped in its powerful fore-legs is an example of Nature photography at its best. There are more than a thousand such photographs, some of them full-page; and both volumes are decorated with a few full-page colour-photographs. Some distribution maps are also included.

The text makes good reading since unnecessary technical terms are omitted, and, though there are many authors, Dr. Burton has done well in keeping the style flowing and consistent.

The subject material has an evolutionary background—the best method of approach in a survey of this kind. Classification, structure and, above all, behaviour, are closely studied. With this object in view, most of the many illustrations are of living animals in action. Having an evolutionary trend, the book must be based on the beginnings and framework of animal life. So there are chapters of the origin, mechanism, history, expression and background of life, followed by a survey of life in and under the sea. These chapters open up Vol. 1, and are followed by seventeen chapters on invertebrates, including seven on the insects. Vol. 2 deals with vertebrates, beginning with some of their forerunners, such as sea squirts and lancelets, etc. In this volume there are twenty-five chapters, seven of which are devoted to birds and eight to mammals. One chapter deals entirely with the psychology of apes. A final chapter is devoted to domesticated animals; but it is a pity that here the text is confined to animals domesticated in countries of the temperate regions, because the book itself deals with animals of the entire world.

This work can be strongly recommended. The very excellence of its illustrations and production in general will appeal to many categories of book-lovers. It is a valuable work of reference, having both systematic and subject indexes (though it is difficult to see why these should be in the reverse order in Vol. 2 compared with Vol. 1). Finally, all students of biology (especially degree students of zoology who have to spend so much of their time on comparative anatomy and not enough on animal behaviour, not to mention physiology) could not do better than get hold of these two volumes, for they are books to have as one's own.

Just a note for the publisher. Vol. 1 deals mainly with invertebrates. Why, therefore, use a photograph of a vertebrate (the lesser anteater, taken from Vol. 2) as the design of the book-jacket of Vol. 1, and another vertebrate (a bird) for the blind blocking on the front cover? Invertebrate *motifs* for the jacket and cover of Vol. 1 would render identification of the volumes easier, especially since the numbers and sub-titles appear only on the spine of each volume.

L. J. F. BRIMBLE

STATIC TRANSFORMERS AND SYNCHRONOUS ALTERNATORS

Les machines électriques des réseaux

Par R. Langlois-Berthelot. Pp. 267. (Paris: Éditions Eyrolles, 1949.) 1700 francs.

THE main plant components of alternating-current systems are alternators and transformers. These machines have been developed in the course of half a century to a remarkable degree of efficiency and reliability, as may be judged from the fact that units exceeding 100,000 kVA. in capacity are beginning to be commonplace. Their working principles are familiar to all electrical engineers and to large numbers of radio amateurs, so that it may appear superfluous to take notice of another book about them. The main justification for doing so is the vast extent to which alternators and transformers are used in providing vital supplies of power and energy. More than one thousand alternators operate in parallel on the British grid system, and many more transformers of large capacity link the generating systems with the interconnecting network.

The transformers are exposed to two main hazards: over-stressing of insulation by lightning strokes to the overhead power lines, and mechanical stresses resulting from short-circuits on the system. The impulsive stresses due to lightning are of the order of 600,000 volts, and the mechanical stresses on short-circuit can reach about a hundred times the normal full-load values. In addition, it is now customary to provide 'on-load' voltage-control equipment in the main transformers, so that they have lost their early simplicity and can justifiably be termed machines. Further complications may also be introduced for phase control, phase transformation, and to provide interconnexion between three or more systems in one unit. Current and voltage transformers used for supplying instruments and protective relays which are so commonplace at low voltages become the most expensive item of a power system per unit of useful output when the system voltage exceeds about 100,000 volts. The problem of finding a more economical method of supplying these small powers is an important one in the development of A.C. transmission. Alternators, too, have become more complicated by the introduction of hydrogen cooling and special excitation devices to obtain maximum stability of operation with machines of minimum weight per unit of output.

R. Langlois-Berthelot gives a clear and interesting account of both classes of plant, which is designed to serve advanced students in technical schools and engineers who have to operate and maintain such plant. He puts his wide experience as a constructor and as a system engineer frankly at the service of his readers, and it would be difficult to find so much practical information in any other single volume. As it is impossible entirely to segregate the problems involved in operating alternators and transformers on an interconnected network, he concludes with an introduction to the study of such networks. This outlines the problems of steady-state operation, short-circuit conditions, stability, surge voltages, power-flow regulation, and optimum utilization of plant from the point of view of duration of life.

All who are concerned with large-scale electricity supply will find the author's treatment to be eminently practical and stimulating. His method, which uses more words than illustrations, will not appeal to many British engineers; but it is not without merit when the words are skilfully used, as is the case in this instance.

C. W. MARSHALL

THEORY OF METALS FOR THE PRACTICAL METALLURGIST

Electrons, Atoms, Metals and Alloys

By Dr. William Hume-Rothery. Pp. 377. (London: Iliffe and Sons, Ltd., 1948.) 25s. net.

THIS book has been written with a particular purpose—to introduce the latest advances in the theory of metals to the practical metallurgist. No one could be better suited to this task than Dr. W. Hume-Rothery, who has made so many important contributions to the subject, and who has yet kept his feet firmly planted on the ground of experimental work. In order to be able to lay stress on the more difficult points, and to anticipate difficulties that may arise in the mind of the practical metallurgist, the author has written the book in the form of a dialogue between a "Young Scientist" (a very able fellow) and an "Older Metallurgist" (a remarkably intelligent person who knows all the right questions to ask).

It is doubtful, however, whether the book will serve the purpose intended; the range of subject-matter is so wide that the ordinary reader, having been conducted through the maze of the electronic structures of the elements (all of them), wave mechanics, free-electron theory, Brillouin zones, electron compounds and nuclear physics, may well be almost as bewildered at the end of the book as at the beginning. Pruning would probably improve the book considerably; general principles could have been emphasized at the expense of completeness, and some sections, such as those on plastic deformation and nuclear physics, could have been omitted completely.

However, it is quite possible that the book will be of considerable value to people other than those for whom it is intended. Those who still find a mental picture useful in absorbing new ideas—and if, in addition, they have to deal with students of the same frame of mind—may often be glad to have this book to turn to for reference. Theorists may protest that the representations are often too precise, but, nevertheless, they are better than the complete absence of representation that many people would have to be content with if they had to rely upon the mathematics alone.

After these general comments, it may seem odd to pick out a single sentence for comment. But why, on p. 64, has Dr. Hume-Rothery stated so emphatically, and apparently unnecessarily, that "It is not the province of Science to answer the question 'Why ?' " ? How much of modern science would have existed had not so many people been actuated by this word ?

MONOGRAPH ON THE BANANA

Bananas

Chemistry, Physiology, Technology. By Harry W. von Loesecke. (Economic Crops, Vol. I.) Pp. xi+189. (New York and London: Interscience Publishers, Inc., 1949.) 36s.

THIS is the first of a series of volumes in which food crops will be given monographic treatment, special attention being paid to their chemical composition and biochemical aspects. This venture, which is justified by the accumulation of analytical data during recent decades, has much to commend it and will be appreciated by those who have to cope with the rapidly growing, but varied and often scattered, literature relating to the major crops. In general, the aim is to assemble and integrate research data relating to the many aspects of the production and the utilization of crops.

In this volume the author has cast his net widely, and within less than two hundred pages has dealt in some detail with the many interesting themes and problems presented by the banana—a major tropical crop and one requiring special care during the post-harvesting phase of refrigerated transport and controlled ripening. Individual chapters are devoted to the history of the banana industry, the structure, development and culture of the plant, the commercial storage and ripening of the fruit, with special reference to the related physiological and biochemical problems, the commercial utilization of banana products, their nutritive value, the diseases and pests that beset the crop, and statistics of the industry in different parts of the world. To cover this ground the author has had to refer to a wide range of literature, some of a rather general nature, but much of it, for example, the physiology and biochemistry of ripening fruit, of a highly specialized kind. In the chapter on the physiology of ripening fruits, a large volume of research results has been brought together for the first time.

Although it is possible to point to some omissions in the text, this work undoubtedly provides a valuable, condensed survey of information on the banana and should accordingly serve the purpose for which it is intended, that is, to enable research workers to become cognizant of what has already been achieved in this varied and interesting field.

C. W. WARDLAW

THEORY OF CRYSTAL GROWTH

By Prof N. F. MOTT, F.R.S.

LAST April the Faraday Society held a Conference on crystal growth[1], and as a consequence of the interest aroused the Physics Department of the University of Bristol arranged a Summer School, held during September 19–24, 1949, in order to explain both the older theories of this subject and some recent advances which have been made in the past year. During the Summer School evidence hitherto unknown to the organisers was produced, which gave a quite dramatic proof of the correctness of some of the theories put forward; and it is with this evidence and these theories that the present article is concerned.

The subject to be discussed is the growth of a crystal face from the vapour or in solution, under conditions where the degree of supersaturation is small and nearly constant over the face. Dendrite formation will not be treated in detail, but a few words are necessary to dispose of it first. Dendrites grow in solution because a corner or protuberance sticks out into a region where the concentration of solute is higher than at other points on the surface, since it is less exhausted by the process of crystal formation; if growth at any point depends only on the local crystallographic orientation and the degree of supersaturation, these corners will grow faster than other points on the surface and form longer protuberances or dendrites, of which the ends will grow faster than ever as they protrude farther. If a crystal grows in a regular form, without dendrites sprouting from the corners, it shows that supersaturation cannot be the only controlling factor.

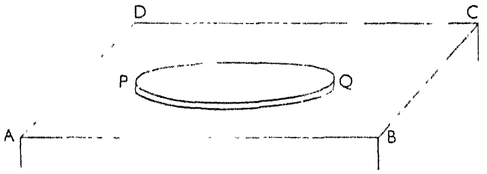

Fig. 1

Gibbs[2] was the first, and Volmer[3] the next to suggest a theory to account for the steady growth of a flat crystal face, even under conditions where the degree of supersaturation is not constant along the surface. This theory was developed in quantitative form by Stranski and Kaischew[4] and by Becker and Döring[5]. According to these authors, the factor which limits the rate of growth of a crystal face such as *ABCD* in Fig. 1 is the difficulty in forming two-dimensional nuclei such as *PQ*. *PQ* is a layer of molecules, one molecule thick and perhaps a hundred across, which is difficult to form, because any smaller-sized group is unstable. Once formed, however, such a layer spreads rapidly across the whole surface, and the process of growth is held up until a new nucleus forms. The chance per unit time that a nucleus is formed at any point depends on the degree of supersaturation there; but the mechanism ensures that the rate of growth of the whole surface is uniform.

An elementary estimate of the rate of nucleation can be made as follows. Assuming the nucleus to be circular and of radius r, its energy will be $-\pi r^2\omega + 2\pi r\sigma$, where ω is the free energy per unit area gained when molecules condense from the vapour on the surface, and σ is the energy per unit length of the steps at the boundaries of the ledge. This has a maximum value $\pi\sigma^2/\omega$ when $r = \sigma/\omega$, and the assumption is then made that the chance per unit time and per unit area that a nucleus is formed is

$$n \exp(-\pi\sigma^2/\omega kT),$$

where n is the number of molecules of the vapour (or solute) hitting unit area per unit time. Elementary considerations show that

$$\omega = kT\,(\ln \alpha)/a^2,$$

where a^2 is the area on the surface occupied by one atom and α is the degree of supersaturation, defined by $\alpha = p/p_0$. Here p is the pressure of the vapour, p_0 the vapour pressure of the solid. The rate of growth thus becomes

$$n \exp\{-\pi a^2\sigma^2/(kT)^2 \ln \alpha\}. \qquad (1)$$

This formula, or formulæ of the same general type, has been deduced by Becker and Döring[5] by a kinetic method, in which the arrival of each individual atom on to the nucleus is considered, and the chance that a large nucleus is formed calculated. Recently at Bristol the theoretical basis of this work has been re-examined in great detail by Burton and Cabrera[1] with special attention to the implicit assumption that the equilibrium surface of a crystal is very nearly a close-packed plane of molecules, and with a more detailed consideration of the shape of the nucleus in various stages of its growth and of the influence of molecular diffusion on the surface of the crystal. It is concluded that, apart from unimportant numerical factors, formula (1) is a correct deduction from the assumptions made.

Formula (1), however, is by no means in agreement with experiment. σa is of the order of the latent heat of vaporization; the insertion of numerical values shows that observable growth-rates will be obtained only if $\ln \alpha$ is at least of the order unity. The experiments of Volmer and Schultze[6] on the growth of crystals of iodine, naphthalene and white phosphorus from their vapours near 0° C. show that the growth-rate is not much less than the rate of incidence of molecules from the vapour and is proportional to the supersaturation, $\alpha - 1$, down to the lowest attainable values, except in the case of iodine when $\alpha - 1$ is less than 0·02. In this case the growth-rate does fall below the linear law and appears to vary as a higher power, perhaps as $(\alpha - 1)^2$, for these very low values of $(\alpha - 1)$.

An explanation of this discrepancy was first given by F. C. Frank[7], and in a paper presented to the Faraday Society Conference. This explanation is based on the theory of dislocations. A dislocation is a line discontinuity of a type which is believed to exist in any plastically curved crystal or any crystal with a mosaic structure; mosaic boundaries can, in fact, be described geometrically as rows of dislocations. There are two important types of dislocation, edge and screw; Frank points out that if a screw dislocation ends on a crystal face, that face has a ledge on it which extends from the point where the dislocation ends to the boundary of the face. This ledge remains, of course, if the surface is covered with one, two, three or any number of layers of atoms; and the face can grow by the rotation of the ledge about the end of the dislocation, without any necessity for the formation of a nucleus. A face on which a screw dislocation ends can thus grow for low degrees of supersaturation; Frank concludes that under those conditions growth is possible only for crystals containing dislocations, and explains in this way the fact that this type of discontinuity, or in other words a mosaic structure, appears in general to exist in crystals investigated. A face with a screw dislocation ending on it is shown in Fig. 2.

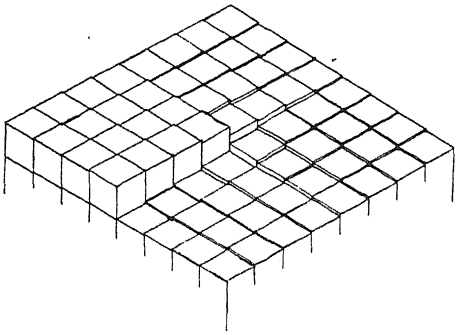

Fig 2*

In the paper quoted, Frank then discusses in detail the form that the ledge will take during growth of the crystal. It will, of course, rotate round the point where the screw dislocation ends, but since each point on a straight ledge will, for a given degree of supersaturation, advance with the same speed, the ledge will soon curl up and form a spiral (Fig. 3). In order to calculate the shape of this spiral it is necessary to know how fast the ledge will advance. A rather difficult calculation[8] shows that a straight ledge will advance with velocity v_0 proportional to ln α, and that a curved ledge of radius of curvature r will advance with a speed

$$v_0 \left(1 - \frac{r}{r_0}\right). \qquad (2)$$

Here r_0 is evidently the size of the smallest nucleus that tends to grow rather than shrink, that for which the free energy is a maximum. Its value is given by

$$r_0 = \sigma a^2/kT \ln \alpha.$$

Using this result, one finds that when the ledge of Fig. 2 has made several rotations it will settle down into the form of a spiral (Fig. 3a), in which the distance between the arms is of order r_0. The rate of growth of the surface is thus of order $v_0\, a/r_0$, and therefore proportional to $(\ln \alpha)^2$—a prediction which seems qualitatively in accord with the results of Volmer and Schultze, that for low values of ln α (that is, of $\alpha - 1$) the rate of growth increases with ln α at a greater rate than the linear law.

It should be remarked that formula (2), and hence the variation with $(\ln \alpha)^2$, depend on the assumption that each molecule which lands on the surface comes off again, on the average, before moving through a distance r_0. At high values of the supersaturation, (ln α), r_0 is small and this will no longer be the case. Under these conditions every molecule which reaches the surface will also reach the ledge, and the rate of growth will become proportional to ln α. When this is so, no quantitative account has been given of the central form of the spiral, but the principal results remain valid.

In the account of the Faraday Society Conference, Frank also gives a sketch of the ledges to be expected in a crystal face on which two screw dislocations terminate, of right- and left-handed sign. These are shown in Fig. 3b. The ledge, starting on the end of one dislocation A, terminates on B; but as the spiral unfolds, its two arms will join together generating a closed loop.

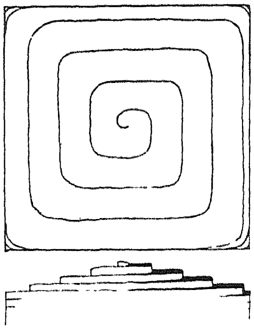

Fig. 3a

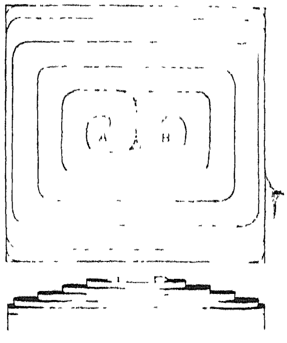

Fig. 3b

This, then, was the form of the theory as it was presented to the Summer School at Bristol. The unexpected experimental evidence in its favour was provided by Mr. J. Griffin, of the Physics Department of the Royal Holloway College, University of London. Mr. Griffin has obtained photographs of the surface of a natural beryl crystal taken with a metallographic microscope, either directly on a crystal surface, or after a light deposition of silver. These photographs show line markings which in general followed contour lines of the crystal surface. There seems to be no reason to doubt that these are the edges of growth-layers; but the rather astonishing further conclusion presents itself as extremely probable, that they are monomolecular growth layers. Calibration by multiple-beam interference fringes has shown that the step in height at such a line is, by an unknown amount, less than 34 A., that is, less than four unit cells of the crystal. One would be hard put to it to explain a consistent unit height of step of this magnitude, which was anything but one unit cell thick. It is very remarkable that a feature of this height (7·9 A.) should be visible in the microscope; but there appears to be no theoretical reason why it should not, and the lines in any event take precisely the form expected for the edges of monomolecular growth terraces. Above all, whereas for the most part they do follow contour lines of the

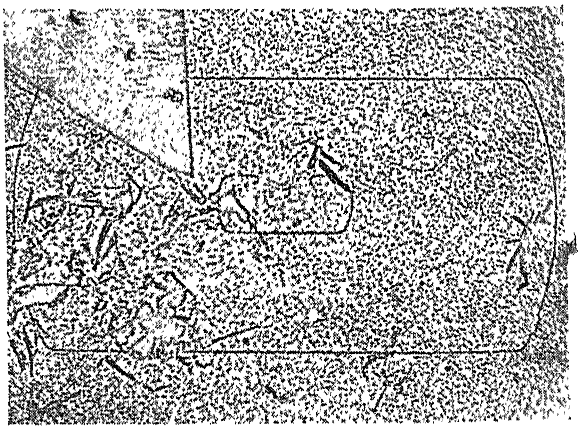

Fig. 4. Prism surface of beryl (× 525)

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* Figs. 2 and 3 are reproduced by permission from the Faraday Society's discussion on crystal growth.

surface, there are particular regions of the crystal face where they terminate in just the manner the edge of a growth-terrace is expected to terminate at a dislocation. Some of the photographs obtained by Griffin correspond exactly to the simple cases of Figs. 3*a* and 3*b* above, Fig. 4 being an example; as well as many more complex examples in full agreement with theoretical expectation.

[1] Discussions of the Faraday Society, "Crystal Growth", **5** (1949).

[2] Gibbs, J. W., "Collected Works" (1878), **1** (Longmans, Green and Co., 1928), footnote on p. 325.

[3] Volmer, M., *Physik. Z.*, **22**, 646 (1921).

[4] Stranski, I. N., and Kaischew, R., *Physik. Z.*, **36**, 393 (1935).

[5] Becker, R., and Döring, W., *Ann. Physik*, **24**, 719 (1935).

[6] Volmer, M., and Schultze, W., *Z. phys. Chem.*, A, **156**, 1 (1931).

[7] Burton, W. K., Cabrera, N., and Frank, F. C., *Nature*, **163**, 398 (1949).

[8] Burton, W. K., Cabrera, N., and Frank, F. C. (to be published).

DOES WILD TEA EXIST?

By F. KINGDON-WARD

SOONER or later anyone interested in the tea plant (*Camellia sinensis*)—its origin, its great variation, and its geographical distribution—comes up against two difficult questions: (1) Does the wild tea plant exist anywhere? If so, where? (2) If not, where and how did the cultivated tea plant of to-day originate?

Our earliest knowledge of the tea plant is necessarily derived from China, where tea drinking dates back some 2,000 or 3,000 years. Whether or not the wild prototype does, or did, grow there, tea was cultivated in south-east China long before it was known to be cultivated anywhere else; and the habit of drinking tea was already prevalent and nearly a thousand years old before it was exported to the West.

But though the Chinese can claim the discovery of tea *drinking* (and, according to Bretschneider, quoted by Watt, used the leaf as a medicine long before that), nothing has been said about the origin of the tea bush itself.

To quote Watt again: "Several writers report having met with the Tea plant in a wild condition in certain parts of China and Cochin China. It was discovered wild, or at all events completely acclimatised, in various parts of Assam, by Bruce. . . ." Evidently Watt did not believe implicitly that wild tea grew in Assam; so he left the way open for a graceful retreat should it prove otherwise. Perhaps he was influenced by Griffith's opinion that the plant found in the Nasareh district of Assam by the early explorers was not the tea plant—meaning thereby, not the Chinese tea plant, which he knew—a conclusion with which most modern botanists would agree. There is a certain ingenuousness in Watt's choice of words—note "the Tea plant in a wild condition" not 'wild tea', and the alternative, "at all events completely acclimatised".

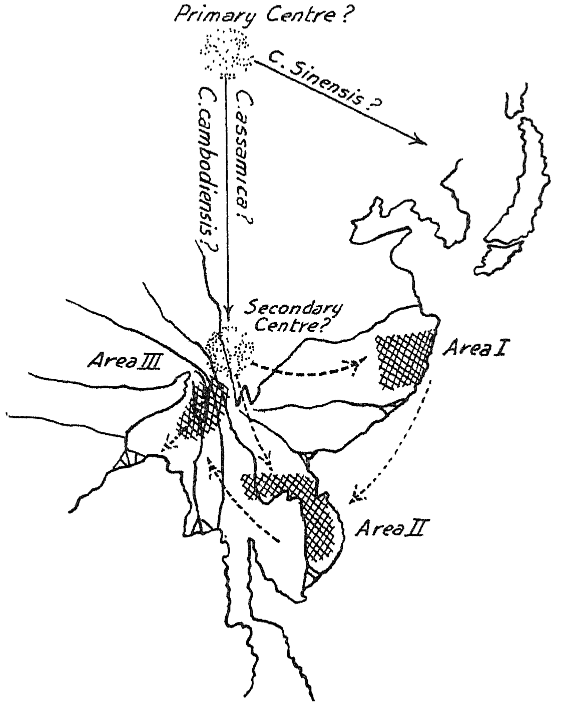
No such doubt is implied, however, when Watt records *his own* discovery of wild tea in Manipur in 1882, although there was rather less likelihood of its occurring wild in Manipur than in the Assam Valley. Actually, the Manipur wild tea is definitely not wild; it can only have been introduced from Burma, probably several centuries ago.

If wild tea exists, it must be rather rare. Many species of plants turn up again and again in herbarium collections; but not tea. One does not find many specimens of *Camellia sinensis* in plant collections from India, Burma, China, Malaya, Siam, or elsewhere. When it does occur, it is expressly stated to be the cultivated plant.

However, the fact that wild tea has not yet been found is no argument against its existence, when one considers the enormous area of unexplored highlands where it might survive. But if we found it, should we recognize it for tea? Not necessarily, surely, as the following considerations will make clear.

Let us first look at the many known varieties of the tea plant of commerce. Dr. W. Wight points out that there are three main races of tea, namely, China type, Assam type and Cambodia type. Further, he suggests that there are two main axes of geographical distribution, which run approximately east to west, and north to south (this last, more exactly, north-west to south-east), crossing at a point where Indo-Burma, Tibet and China meet—about lat. 29° N., long. 98° E. These two axes correspond roughly with the river valleys from the Brahmaputra to the Yangtze, between which lie the southward flowing Irrawaddy, Salween and Mekong, and the south-eastward flowing Red and West Rivers. Note that these valleys radiate out over nearly 180° of arc, like the spokes of a wheel.

It will be immediately remarked that the three extreme races of tea lie on the outer rim of this fan-shaped area, down which roll the great rivers of South-East Asia, and up which man would be likely to move. This will be made clearer if instead of two intersecting axes we recognize three principal routes of dispersal radiating from a centre somewhere near the sources of the Irrawaddy, each route ending with one of the three races concentrated in a terminal area. It would seem that the distribution of the tea plant in one form or another, 'wild' or cultivated, is more or less continuous along these three radii, the terminal areas of which are primarily occupied by (1) China type, (2) Cambodia type, (3) Assam type.



But while the extreme races are thus dispersed at wide intervals on a great arc reaching from the mouth of the Yangtze to the mouth of the Ganges, they do not occur singly at those extremities. In south-east China, for example, there is found not only the China type, but also the Assam type; in Indo-China certainly the Cambodia type and the Assam type, and very possibly the China type also; in Assam-Burma both the Assam type and the Cambodia type. (The influence of this last was long ago recognized by Dr. Wight, and more recently again in specimens of 'wild' tea collected by me in Manipur in 1948.)

It is worth recording that the peculiar type of *C. sinensis* which, according to Watt, has never been found wild, is "more abundantly represented in herbaria as coming from India than from China". It is the plant which everybody acclaims as tea, and is markedly different from all other races.

Some years ago Dr. Wight observed that Assam 'wild' tea always occurred close to one or other of the great highways of the Ahom kingdom, such as the Char Ali and Dhodar Ali—never in climax forest. It was invariably found in small patches, not dispersedly, in ground which might well have been formerly cultivated; just as it is found to-day, close to present or past village sites. Almost all later discoveries of 'wild' tea in Assam (as near Jaintiapur and in East Manipur by me) tend to confirm the correctness of this observation, which was accepted by the Dutch botanist Wellensieck when he visited Assam in 1937 and was shown some of the original 'wild' tea.

The occurrence of wild tea in Indo-China has long been known. Pierre recognized five varieties, and Eberhardt says that wild tea occurs along the whole length of the Annamite Chain from the extreme north of Tonkin to Cochin-China, and also in Laos. Thus, in fact, it occurs over the whole peninsula, as well as in Siam.

Of tea called wild in south-eastern China we know little. It has already been remarked that wild China tea is unknown; but the plant is cultivated throughout the black tea district. Forms of the Assam type, however, are also cultivated; and since all reports of cultivated tea, whether in plantation or village, speak of great variation, from which it is possible to isolate distinct strains, it seems certain that most cultivated teas are hybrid. The only exception is pure 'China' —if such exists! This is the more intelligible when we remember that tea is self-sterile, and that more than one race of tea exists in each area.

If the Assam type occurs in China as well as in Burma-Assam, it is not surprising that it should have found its way southwards into the Indo-Chinese peninsula. It is less easy to see how the Cambodia type reached Manipur.

Thus it is clear that in the three terminal tea areas, each dominated by one of the three major races, not less than two of those races actually occur; and further, that tea under cultivation, even in China, is a very variable plant—much more so than in some of the newer planted areas such as Java and Ceylon, where 'wild' tea is not found. If one may judge from Dr. Wight's experience in Assam, this variation is due to crossing.

The complex now known as *Camellia sinensis* has in earlier times been regarded as two distinct genera —*Camellia* and *Thea*; and the three main races are, in their extreme forms, so dissimilar that it would be reasonable to regard them as species, the more so since another plant, derived from an uncertain source in northern Burma, which has many of the characters of tea and crosses easily with it, cannot be assigned to any of the three major races, and must be regarded as a different species.

Clearly, then, the prototype of these three races, if they had a common origin, may have been something different again, and not at first sight obviously tea. For there is no evidence that they have been derived from one another. On the other hand, a plant like *Camellia taliensis* might equally be regarded as tea.

This brings us to the question: If wild tea does exist, what manner of plant is it? Is it a dwarf leathery-leafed bush like the China type, a small fastigiate tree with large leaves like many forms of the Assam type, or a small tree with moderate-sized leaves turning red in autumn like the Cambodia type? Or does it resemble none of these closely?

In attempting to discover a wild ancestor of the tea plant of commerce, three possible lines of research suggest themselves: (1) the historical approach, including archæology; (2) a knowledge of the distribution of all the species of *Camellia*, which might help us to arrive at a centre of diversity and indicate the probable direction of migration; (3) an investigation of all the varieties of *C. sinensis*, with the view of discovering where is the chief 'centre of diversity'. Let us examine these in turn for evidence.

(1) The history of tea, so far as it is known, has been told so often that it is unnecessary to repeat it here. The best account is probably that given by Watt[1]. The most ancient records deal with tea drinking (or with medicinal use) rather than with the plant itself and its origin; and there can be little doubt but that it is one of the more ancient cultivated plants, which may well go back to prehistoric times. But prehistory has thrown no light on the problem, nor would one expect it to do so, in a climate such as that favourable for the growth of tea. There is no evidence that tea had penetrated even so far west as the Indus civilization in prehistoric times. (Naturally the plant itself could not spread to the dry civilizations.)

Thus the early history of tea, and how knowledge of its use was spread, must be inferred from other sources, indirectly; perhaps not least from considerations of geography, and the migrations of peoples in South-East Asia. But it would help if we knew where it originated.

(2) The genus *Camellia* is restricted to the highlands of South-East Asia, from Japan to the eastern Himalayas as far west as Nepal. The most widespread species, if we accept all the reports of wild tea as wild, is *Camellia sinensis*, and the most widespread race of *C. sinensis* appears to be the Assam type.

Excluding tea in all its forms, some fifteen or twenty species of *Camellia* have been described—or at least named. Of the undoubted species, at least four are found in Assam (mainly south of the Brahmaputra), three on the Burma–Yunnan frontier farther east, and at least three in south-western Yunnan. That is to say, at least half the known species, and possibly two-thirds, come from the Assam–Burma–West China area, which is characterized (though not exclusively) by the Assam race of *Camellia sinensis*. This area, then, which I have called No. 3, would seem to be the centre of concentration, and the centre of diversity, using the term in the same sense in which it is used by Vavilov.

(3) Some indication of the races and varieties of *Camellia sinensis* has already been given. When we look for a centre of diversity for cultivated tea, we are met by the difficulty that so comparatively restricted is its range, and so continuous its distribution (as compared, for example, with wheat and rice), that any centre of diversity almost coincides with the total range, at least on the evidence at present available, and would have to include Indo-China (area No. 2) and the eastern China region (area No. 1). Plants which occur in Japan or Formosa, and, skipping two thousand miles, crop up again in the eastern Himalaya (they are not a few) can scarcely have acquired that peculiarly interrupted distribution except on the supposition that they were dispersed from a restricted area and fled southwards, however slowly and sedately, along radial or longitudinal communication lines, either valleys or mountain ranges. The common centre from which they set out may have been as far north as the 60th parallel, or even within the Arctic Circle. It may, on the other hand, have been farther south, in the Altai or some part of the Mongolian plateau.

Obviously, we do not know whether the strongly marked races of tea reached the terminal areas as races (or species), or whether they evolved from a single uniform race *in situ*. The most divergent race, at least in appearance, is the China type—the only one that nobody has claimed to have found growing wild. The Assam and Cambodia races are far less unlike in appearance—apart from the amount of anthocyanin present in the latter.

That the Assam and Cambodia races may have had a common origin where the divergent threads of the great rivers are gathered together is suggested by the discovery of a *Camellia* in the Mishmi Hills in the north-east corner of Assam, in 1949. This plant (*K.W.* 18530), of which the specimens* comprise foliage only, was found growing completely wild in the hill jungle, and is undoubtedly tea—*Camellia sinensis*. Judging by the leaf, it is of the Assam race; but without either flowers or fruit, it would be rash to say more.

Yet it is difficult to believe that the China race, so different in habit and appearance, has not had a separate origin, especially when we find that the teas grown in western China, both in the north (Yachow district of Szechuan) and in the south (Puerh district of Yunnan), are of the Assam race, which, in fact, through the hilly country of south China, reaches eastwards to the coastal tea districts.

It seems possible, then, that the China race came from the north around the Pacific seaboard, as other elements of the flora did, during the glacial shake-out; while the Assam race took the more direct route from Central Asia. If this view is correct, the China type has had one origin and the Assam and Cambodia races another, further implying that the Irrawaddy region is a secondary centre of dispersal, and that we must look much nearer to Central Asia for the primary centre. We are unlikely to find any but indirect evidence for the truth of this.

During the long, if limited, glaciation of northern Asia, the primary centre of dispersal would have been operative, as in Europe and America. Thus, we find a correspondence between the floras of Japan and of the eastern Himalaya. The dispersal of species from the secondary centre is more recent. The eastern Himalaya show clear signs of intense glaciation, with glaciers descending almost to the plains of Assam and northern Burma, which even the heavy rains of this region have been unable to wipe out. In the Mishmi Hills, and even so far south as East Manipur, I have found unmistakable, if fainter, evidence of glaciation; and it seems probable that within the last ten thousand years or less the climate has become more genial, allowing a considerable resettlement of the refugee flora, which has found its way northwards again up the warm damp valleys.

Yet, apart from the dispersal of the genus *Camellia*, the dispersal of the races of tea in South-East Asia is no simple matter. It is worth noting the almost invariable association of tea with the Thai (Shan) people. In the Upper Yangtze Valley (whence the Thai may have sprung), in south-east China and southwards to Laos and Siam, westwards to Yunnan, Burma and Assam, to every region where the Thai have gone, now as conquerors, now as refugees, the village cultivation of tea has been a cottage industry, and wild tea has been reported.

It is therefore tempting to identify the dispersal of tea with the historical records of Thai migrations. Unfortunately, though the Thai no doubt first reached south-east China from the direction of Central Asia, their later movements were westwards rather than eastwards, and southwards rather than northwards. It thus becomes difficult to correlate the early eastward spread of the Assam type with the Thai, though easy enough to account for any later movements of it (though not, apparently, of the China race) south-westwards. One can do no more for the present than await further evidence.

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* In the herbarium of the New York Botanic Garden; and of Tocklai Tea Research Station, Assam.

[1] "The Commercial Products of India."

OBITUARIES

Dr. Leonor Michaelis

Dr. Leonor Michaelis, member emeritus of the Rockefeller Institute for Medical Research, died recently in his seventy-fifth year. Thus ended the career of one of the most prolific and original scientific minds of the twentieth century.

Dr. Michaelis was of those rare individuals possessed of a healthy body and endowed with the precious gifts of genius. He learned with ease, his memory was tenacious, he could quickly grasp the essence of a problem, he was a vigorous, persistent and meticulous worker. Aware of these blessings, he was a modest man.

Leonor Michaelis was born in Berlin in 1875 and entered the University of Berlin in 1893. In his early days he was an enthusiastic mountain climber, and also well-nigh a necromancer of the then newly developing silver bromide plate. In later years one of his absorbing devotions was to music; with little formal training, he was an accomplished pianist and composer. Once at a gathering of friends, in response to a request, he sat down at the piano and, on the theme of "Yankee Doodle", extemporized a sonata in perfect classical form, in four movements, ending with an elaborate and lively fugue. Another of his avocations was comparative linguistics and philology; and during his three-year visit to Japan he studied the Japanese and Chinese languages.

While a student at the University of Berlin, Michaelis assisted in the laboratory of Prof. Oskar Hertwig. His first paper, in 1897, was on the problem of whether the point at which the sperm fertilizes the egg determines the first cleavage furrow. The answer was no, and recently he remarked, with a twinkle in his eye, that this finding still seemed valid. In the next year he published a paper on the histology of milk secretion, which was awarded a prize from the medical faculty. His gift for exposition and for a grasp of the particular field of his study was made evident in the writing at this time of a text-book on embryology for medical students, which in rapid succession went into some nine editions.

In Berlin his work came to the attention of Paul Ehrlich, who offered him a position as assistant. Here he studied the histological staining properties of the various new dyes then under elaboration by the German chemical dye industry ; and while so doing he discovered the specific vital-staining effect of Janus Green on certain cytoplasmic bodies which were later to become known as mitochondria. In this new field of his endeavour he wrote a text-book on the chemistry of dyestuffs for histologists, a book which revealed a mature understanding of the basic chemical processes underlying the staining techniques.

For a few years after he worked on the transplantation of mouse cancer, and was among those who first found that the success of transplantation depends on the strain of the species used. He also observed a marked change in the immunological specificity of serum albumin when digested for an exceedingly short time with pepsin.

In 1905, Michaelis became bacteriologist in the municipal hospital in Berlin, and in close co-operation with Peter Rona undertook problems which were primarily in the newly developing field of physical chemistry. His main life's work was to be in this field, and in it he could use to the fullest his abilities to ask questions about living things and set up basic experiments involving few variables. His laboratory was on a most primitive and restricted scale. The City administration strongly discouraged any kind of research in municipal hospitals. Such work was frowned upon also by the director, who could not see how studies of such problems as hydrogen-ion concentration in relation to enzymic activity, fundamental studies on electrophoresis of proteins, a theory of enzyme affinity for substrate (Michaelis–Menten), studies on enzyme inhibitors, the problems of exchange adsorption of dyestuffs—how all these could be related to the cause and cure of disease. Only later were his studies realized to have provided integral parts of the framework of our knowledge of enzyme action and protein behaviour. In 1914 his book on hydrogen-ion concentration appeared, which was to become a classic in the field of physical chemistry. At this time also he wrote his stimulating book on "Dynamics of Surfaces", and his manual of physical chemistry. For the purpose of his investigations he found it necessary to learn more mathematics, and he summarized his studies on this theme in another fine book, "Mathematics for Biologists and Chemists", published in 1921.

In 1922 he was invited as visiting professor in biochemistry to the Medical School of Nagoya, Japan. This was an unusual event, since no foreigner had been engaged as full professor in Japan for a long time. He remained there for three years, was greatly honoured, had many graduate students, and was provided with excellent facilities for research. Here he began studies on permeability with artificial membranes specifically permeable to positive ions. Of the permeability of the living membranes he once remarked, "We know what it can be, what it might be, and still it is different".

In 1926 he went to Johns Hopkins University as a resident lecturer, and three years later was appointed a member of the Rockefeller Institute for Medical Research. The field of his main achievements in the United States centred around problems of oxidation and reduction. He was not only interested in investigating these problems, using the customary formal thermodynamic approach, but also at the same time inquired into the specific mechanisms by which these oxidations could take place. Early in this work he developed an ingenious theory of heavy metal ion catalysis, based on the formation of Werner complexes, to explain the effect of iron in catalysing cysteine oxidation with oxygen. This study was soon followed by the fundamental discovery of organic radicals stable in aqueous solutions, the 'semiquinones', a discovery arising from inquiries into the anomalous behaviour of certain compounds during potentiometric titration. The idea of the existence of organic radicals in aqueous solution met with considerable opposition, so much so that his first paper on the subject had to be published in European journals. A firm and independent proof of the existence of these semiquinones, or radicals containing unpaired electrons, was provided by magnetochemical experiments. Different organic compounds provided further examples of these radicals, the stability of which is most readily accounted for on the principle of resonance. Some of these observations are summarized in his book on oxidation-reduction potentials, which has been translated into a number of languages. The beautifully developed thermodynamic equations of semiquinone formation were used in one paper to obtain values of acidity in strongly acid solution. The dimerization of the organic radicals led him to investigate the dimerization of dyes and other molecules, and to renewed studies of the metachromatic effect of dyes in histological staining, a problem which had intrigued him in his early years with Ehrlich. Further magnetochemical investigations included the studies on ferritin iron, on ferric phenanthroline, on the reversible oxygenated complexes of cobaltiac and of cobalt histidine.

Among other subjects he investigated was the conversion, using thioglycollate, of keratin into soluble material. The principle of this study is to-day the basis of the 'cold permanent wave' industry of cosmeticians. His most recent feat was the discovery of the radical of vitamin E, a discovery which may prove to be basic to an understanding of the action of this vitamin.

Dr. Michaelis is survived by his wife, Hedwig Philipsthal, and his two daughters, Ilse Wolman and Eva M. Jacoby.

By those who knew him closely and worked with him, Dr. Michaelis was respected and honoured. By his contemporaries his abilities were envied and admired. His influence on the world of science will be lasting.

S. GRANICK

WE regret to announce the following deaths :

Mr. A. J. Wilmott, deputy keeper in the Department of Botany, British Museum (Natural History), on January 27, aged sixty-one.

Prof. W. P. Wynne, F.R.S., emeritus professor of chemistry in the University of Sheffield, on February 16, aged eighty-nine.

NEWS and VIEWS

A Big Sunspot

A BIG group of spots, brought into view by the sun's rotation on February 14, has crossed the sun's disk and will pass out of sight on February 27. In northern latitude 11°, the centre of this complex group crossed the central meridian on February 20.2 U.T. At the time of this notification (February 18), the area covered by the spots was nearly 3,000 millionths of the sun's hemisphere, or about seventy times the cross-section area of the earth. This group will probably not have been exceeded in size since 1947 (the peak year of the present eleven-year sunspot cycle), when the outstanding group had an area nearly double that of the present one. Judging from size alone, the present group is quite likely to be associated with geomagnetic and ionospheric disturbance, the most likely times being February 18–24.

Planets and Sunspots

K. G. MELDAHL, who has produced some previous works on tidal forces in the sun's corona due to planets, Part 1 in an English edition in 1938 (see *Nature*, 144, 726; 1939), has now published Part 2 (Berlinste Forlag, Copenhagen). This consists mainly of six figures showing the relative magnitude, heliocentric direction, continual recurrence, and the period of 308·52 years of the tidal force, printed on a single roll. The calculations cover 498 years—from 1663 to 2160—and the close agreements between the regions of the years 1843 and 2152, shown in Fig. 2, confirm this period of 308·52 years. It is shown that there are a period of about 0·97 year and another of about 5·56 years, or multiples of both (the latter being half the average sunspot period), permeating the whole of the field. The same planets are dealt with as on previous occasions, namely, Mercury, Venus, Earth, Jupiter and Saturn; and it is claimed that the connexion between the tidal period and the observed average sunspot periods has been established by the ever-recurring and interacting periods of 5·56, 11·12, etc., years. It is hoped that careful observations will be carried out on the interaction between the auroras and tidal forces and their directions; Figs. 3 and 4 show this and explain the prediction in 1937 for the great auroras in 1938, afterwards verified, and also for somewhat similar conditions during January and February 1950. While this note was in course of preparation, there has been a remarkable fulfilment of these last predictions. Exceptional auroras observed in Denmark were responsible for some alarm among the fire brigades, which took them at first for large fires. In addition, Dr. Meldahl has been observing auroras in Fredrikstad, Norway, from the middle of January until the middle of February, and from all the evidence it seems that his theory deserves much more consideration than it has previously received.

Atomic Physics at the Science Museum, London

A MODEL of the first atomic pile at Harwell, the Graphite Low-Energy Experimental Pile (G.L.E.E.P.), has been lent to the Science Museum, South Kensington, London, S.W.7, by the Ministry of Supply and is now on exhibition on the second floor of the Museum. This pile went into operation in August 1947 and has been used for making radioactive isotopes, for measuring the properties of atomic nuclei, and for testing the nuclear properties of materials used in pile construction. Among neighbouring exhibits at the Science Museum are other pieces of apparatus which have played a notable part in the development of atomic physics, including Aston's original mass-spectrograph of 1919 with which atomic masses were first accurately compared, and part of Cockcroft and Walton's original apparatus with which artificial nuclear disintegration by purely electrical means was first achieved in 1932.

In a recently re-opened gallery on the top floor of the Museum further exhibits relating to modern physics may be seen. Several models illustrate the structure of atoms and molecules, while another, larger group of exhibits shows the development of electron physics. Included among them are many working models and illuminated diagrams to demonstrate principle; one shows the various controls of a cathode-ray tube and their function; another demonstrates the response of photocells of different types to variations in the intensity and colour of the light falling upon them. Historical development is covered by the exhibition of original apparatus in the usual sequence; there are also exhibits, which can be worked by the visitor, designed to show the principles of historic experiments such as those of J. J. Thomson which led to the discovery of the electron.

Ciphering of Organic Structural Formulæ

THE Commission on Codification, Ciphering, and Punched Card Techniques, set up by the International Union of Pure and Applied Chemistry, has issued a list of attributes to be considered in judging systems for ciphering organic structural formulæ, and invites all persons who may have developed ciphering systems to submit them to the Commission. The following points should be considered: (1) simplicity of usage; (2) ease of printing and typewriting; (3) conciseness; (4) recognizability; (5) ability to generate a unique organic chemical nomenclature; (6) compatibility with accepted practices of inorganic chemical notation; (7) generation of an unambiguous and useful enumeration pattern; (8) ease of manipulation by machine methods, for example, punched cards; (9) exhibition of association (descriptiveness); (10) ability to deal with partial indeterminants. Those submitting ciphering systems will be given an opportunity of proposing additions to the above points. Detailed descriptions of new systems should be sent before March 1, 1950, to the acting secretary of the Commission, J. W. Perry, Room 20-E-215, Massachusetts Institute of Technology, Cambridge 39, Mass. In order to ensure that nothing is overlooked in subsequent testing, those submitting systems will be asked to demonstrate the application of their systems by a list of compounds compiled by taking the first four entries on every hundredth page of Beilstein. At present four systems, none of them in completely developed form, have come to the attention of the Commission.

British Institute of Management

IN his chairman's address to the British Institute of Management at its second annual general meeting, Sir Charles Renold stated that although the Institute only opened its doors in a temporary office on September 1, 1947, good progress has been made in selecting staff and finding accommodation, in spite of unexpected difficulties. Arrangements have been completed for a seven-year lease of a block of buildings on the other side of Hill Street, London, W.1, from its present premises, and the staff now numbers 118, mainly engaged on clerical and secretarial duties. The Information and Research Department comprises four divisions, concerned with finance and office management, personnel management, marketing and sales management, and production management, and includes the reference library. As regards finance, Sir Charles estimated that the Institute would at the earliest possible date require an annual income of not less than £100,000 in order to free itself from government financial assistance. It is hoped by 1952 to secure a fully representative council in which all the originally nominated members would be replaced, unless re-elected individually for a further term, and that it would soon be possible for the council to reach decisions on the fundamental principles involved in implementing the recommendation of the Baillieu Report with regard to the establishment of the Institute as a professional body with defined grades of membership. The Institute has already taken over the functions of the British Management Council, and the agreement with the Institute of Industrial Administration is designed to lead to a complete merger at the end of three years. Good progress is being made in building up a comprehensive information service, and the education committee is reviewing the whole field of education for management. Discussions have already taken place with university authorities on the contribution which the universities could make in this field.

Journal of the Science of Food and Agriculture

THE Society of Chemical Industry published in January the first number of a new monthly, the *Journal of the Science of Food and Agriculture* (1, No. 1; 1950. 3*s*., or 30*s*. per year; to members, 8*s*.). This new publication relieves the Society from the difficulty of finding room in the *Journal of the Society of Chemical Industry* for the increasing number of papers on food and agriculture which have been competing for space. Messages of goodwill from the respective Government Ministers indicate the importance that is attached to these two fields of activity, and this receives further emphasis in an article by Viscount Bruce on the work of the United Nations Food and Agriculture Organisation. It is perhaps significant of the present trend of food research in Great Britain that out of the seven research papers published in this number, three deal with fruits, one with vegetables, one with cereals, and only two with animal products. Vitamin C figures in two papers: one from the Royal Forest Factory at Coleford gives an interesting account of ascorbic acid oxidase inhibitors in black currants, and the other from the Lyons Laboratories, London, and the Western Province Fruit Research Station, Department of Agriculture, Union of South Africa, compares the vitamin-C content of English and South African cabbages. Two papers, from the Lyons Laboratories and from the Defence Research Laboratories, General Chemistry Section, Maribyrnong, Victoria, provide valuable analytical data on fruits and on elephant-seal oil respectively. Three papers deal with general biochemical problems: prevention of staling in bread (Government Laboratory, London); the combination of sulphur dioxide with concentrated orange juice (Low Temperature Research Station, Cambridge); and the oxidation of fat in dehydrated herrings (Torry Research Station, Aberdeen). Readers will look forward to further numbers, which will furnish a balanced picture of food and agricultural research being undertaken by academic and industrial workers in Great Britain as well as in other parts of the Commonwealth.

Industrial Postgraduate Course in Engineering

A LEAFLET recently issued by the British Thomson-Houston Co., Ltd., reprints an article from *BTH Activities* which describes the advanced engineering course instituted two years ago by the Company at the Rugby works. This is a course of advanced lectures in mathematical analysis applied to physical and engineering problems which is given to a group of graduate apprentices. The course comprises two lectures each week given in working hours, and associated with the lectures is an evening tutorial class of two hours duration. The general character of the course, which extends over two years, may be gauged from the following list of topics. *First-year course:* general revision; vector field theory; operational calculus; theory of elasticity. *Second-year course:* differential equations; complex variable theory; determinants, matrices and tensors; mathematical statistics; advanced dynamics. Normally some sixteen men are selected for the first-year course, and at the end of the first year a further selection of a smaller number is made from those who wish to proceed to the second year. The purpose of the course is to meet the need experienced by those engaged in advanced design and research for mathematical equipment beyond that provided by the undergraduate course at the university. The basic mathematical work occupies one of the weekly lectures, while the second lecture deals with a related practical problem. Each of the practical lectures is given by an engineer who is a specialist in the subject. This intimate contact of the course with actual engineering problems not only stimulates the interest of the students but also ensures its development to keep pace with advances in practice.

Brotherton Collection, University of Leeds

THE thirteenth annual report of the Brotherton Collection Committee covering the session 1947–48 (pp. 12; University of Leeds, 1949) gives the contents of the Collection on June 30, 1948, as 22,764 books, 15,615 pamphlets, 477 manuscripts, 4,105 deeds, 31,216 letters and 25 maps. Cataloguing of nineteenth-century English literature continued, and 1,558 slips were added to the catalogue. Work has been commenced on the compilation of a detailed list of notable people whose correspondence with Sir Edmund Gosse is preserved in the Collection. The first of three exhibitions in the main Brotherton Room traced the development of the art of book illustration from the fifteenth century to the work of modern illustrators, while a third exhibition traced the development of the art of printing from Gutenberg to the present day. An exhibition of more special interest covered recent publications of the North American university presses.

Work of the British–Kenya Miocene Expedition during 1949

THE work carried out in 1949 by the British–Kenya Miocene Expedition was financed by a grant from the Kenya Government and by funds made available by Mr. C. W. Boise for the purchase of a motor-boat to facilitate work on the islands in Lake Victoria. The activities during the season, which started in February, were completed at the end of November, and resulted in the collection of 2,043 specimens of Miocene fossils. On the specimens, 134 represent the remains of primates (anthropoid apes, cercopithecoid monkeys and lemuroids). The remainder of the collection includes *Dinotherium*, rodents, shrews and fossilized fruits, seeds, etc. In August, a number of islands situated north and west of Rusinga were explored, but no Miocene exposures were found in them. In September, the fossil beds which had been reported by Prof. R. M. Shackleton in the Maralal–Rumuruti area were examined; but they proved disappointing, since the fossils in them were found to consist mainly of very fragmentary remains of fish, crocodile and tortoise. Excavations at Songhor led to further discoveries of isolated teeth of the large species of *Proconsul* (*P. major*), of which the type specimen was found in 1948.

Indian Heart Journal

Records of the progress of science and medicine in India continue to find publication, and the first issue of the *Indian Heart Journal* (pp. 100; 1949; Cardiological Society of India, 67 Dharamtala Street, Calcutta 13; 7.8 Rs. or 15*s*.) launches a new publication devoted to the study of the heart and circulation and allied subjects. This first issue contains six original articles, all by Indian authors, together with some abstracts of current literature and a book review. Well produced and convenient to handle, the journal will put cardiologists all over the world in touch with the work of their colleagues in India.

Foreign Scholarships for British Students

A number of foreign governments and universities are offering scholarships to British students for the year 1950–51, most of the scholarships providing for a year of postgraduate study in the foreign country concerned. Arrangements are made through the British Council. The countries which are continuing schemes already in operation are: Belgium, Czechoslovakia, Denmark, Finland, France, Germany (Universities of Cologne and Munster), Italy, the Netherlands, Norway, Persia (University of Teheran) and Sweden. In addition, three new scholarships, each valued at £640, are being offered by Brazil, and another is tenable at the University of Neuchatel, Switzerland. The closing date for applications is March 10, and the awards will probably be announced by the beginning of the normal university summer term. Details of these scholarships are contained in a booklet issued by the British Council and obtainable from the Controller, Education Division, British Council, 3 Hanover Street, London, W.1.

University of Birmingham

The following announcements have recently been made in the University of Birmingham: W. B. Watson has been appointed lecturer in mining; R. W. Stuart Mitchell has resigned his lectureship in mechanical engineering on being appointed chief research engineer, Diesel Engine Division, English Electric Co., Ltd.; the degree of doctor of science, in the subject indicated, has been conferred on R. S. W. Thorne (industrial fermentation) and H. B. Whittington (geology).

The Night Sky in March

Full moon occurs on March 4d. 10h. 34m., U.T., and new moon on March 18d. 15h. 20m. The following conjunctions with the moon take place: March 4d. 16h., Saturn 0·3° N.; March 6d. 06h., Mars 4° N.; March 14d. 18h., Venus 9° N.; March 15d. 20h., Jupiter 3° N.; March 31d. 23h., Saturn 0·1° N. In addition to these conjunctions with the moon, Mercury is in conjunction with Jupiter on March 1d. 15h., Mercury being 1·2° S. Mercury is too close to the sun for favourable observation and is in superior conjunction on March 28. Venus is a morning star, stellar magnitude – 4·3, and rises about 1½ hours before the sun throughout the month. The visible portion of the illuminated disk increases from 0·2 to 0·4, and on March 6 the planet attains its greatest brilliancy. Mars, in the constellation of Virgo, rises at 20h. 10m. and 17h. 10m. at the beginning and end of the month respectively, and is in opposition on March 23. Jupiter, a morning star, is too close to the sun for favourable observation until the end of the month, when it rises about an hour before the sun. Saturn, in opposition on March 7, is visible throughout the night in the constellation of Leo. An annular eclipse of the sun on March 18 is invisible at Greenwich but can be seen over portions of the southern hemisphere. Occultations of stars brighter than magnitude 6 are as follows: March 7d. 03h. 00·9m., α Virg. (*D*); March 7d. 03h. 38·1m., α Virg. (*R*); March 23d. 20h. 30·2m., 23 Taur. (*D*); March 23d. 21h. 54·5m., 27 Taur. *m*, (*D*); March 26d. 23h. 40·6m., 49 Auri (*D*); March 28d. 19h. 20·3m., λ Canc. (*D*); March 31d. 21h. 22m., χ Leon. (*D*). *R* and *D* refer to reappearance and disappearance respectively, and the latitude of Greenwich is assumed. Vernal equinox is on March 21d. 05h.

Announcements

The Principal Trustees of the British Museum have appointed Prof. G. R. de Beer, professor of embryology at University College, London, to be director of the British Museum (Natural History) with effect from May 1, 1950, in succession to Mr. N. B. Kinnear, who is retiring.

The Institution of the Rubber Industry is organising a conference on "Rubber as an Engineering Material", to be held at the Overseas League (Headquarters), Park Place, St. James's, London, S.W.1, on March 17. Further details can be obtained from the Secretary, Institution of the Rubber Industry, 12 Whitehall, London, S.W.1.

The Royal Statistical Society has recently received an anonymous benefaction of £30,000 to enable it to acquire premises worthy of its history, traditions and scientific work as a learned society. It has outgrown its present premises at 4 Portugal Street, London, W.C.2, and for some years has been seeking a building in which its large and valuable library may be housed and in which its work can be adequately carried out. The growing recognition of the importance of statistics in government, business and science may be gauged by the increase in the number of fellows from a thousand in 1938 to more than two thousand at the present time.

The Congress of the International Society of Hæmatology will be held in Cambridge during August 21–26, 1950. Sessions will be devoted to discussions of anæmias, leukæmias, blood coagulation and immuno-hæmatology. Applications to attend the Congress should be sent at once to the Congress Secretary-Treasurer: Dr. Martin Hynes, Department of Medicine, University of Cambridge.

RETINAL OXYGEN SUPPLY AND MACULAR PIGMENTATION

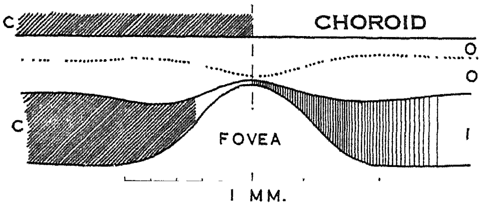
IN their recent communication under the above title, Drs. Dartnall and Thomson[1] write that the presence of the yellow pigment in the fovea of the human eye will make it less efficient for vision ; they suggest that the pigment is there to carry oxygen to those regions of the fovea which have no capillaries.

The presence of a pigment with a strong absorption in the blue may, however, be an advantage, rather than a disadvantage, from the point of view of visual acuity, because chromatic aberration becomes greatly disturbing at the short-wave end of the spectrum. Fick[2] as early as 1875 stated that it is the chromatic aberration which will set a natural short-wave limit to the human visible spectrum. It would therefore seem appropriate that the region of the highest acuity should be made less sensitive to short-wave radiation.

In blue or violet light the human 'emmetropic' eye is actually myopic, to the extent of about 1 dioptre[3,4]. Absorption of the blue and violet radiations on their way to the photo-receptors should therefore be beneficial for accurate focusing of the retinal image in ordinary daylight. It is true that objects which reflect blue or violet radiations will then tend to look darker than they would otherwise look ; but this is not necessarily always a disadvantage. On the contrary, when they are seen against a bright background of another colour, this will increase the brightness contrast and improve acuity. Thus it is not unreasonable to suppose that the function of the yellow pigment of the macula may be to absorb these short-wave radiations in order to improve foveal acuity.

The suggestion that the yellow pigment may be concerned in the respiration of the tissues of the fovea receives little support from a consideration of its distribution, as shown in the accompanying diagram. First, according to Schultze[5] and Polyak[6], the pigment is only found in the inner layers of the retina, being absent from the outer layers which contain the photo-receptors. The respiration of these outer layers, which account for most of the retina's thickness in the capillary-free area of the fovea, must therefore be carried out without the aid of the pigment. Secondly, the major part of the yellow pigment is found in the foveal slopes[5,6] which have capillaries[7,8], and in which it should apparently not be needed for respiration.

In the extra-macular region, it is probable that respiration depends on oxygen supplied to the tissues by diffusion from the capillaries of the choroid and of the inner retinal layers. Referring to the geometrical conditions as shown in the diagram, one may wonder whether foveal tissues cannot be supplied in the same way. In view of the lack of information on the oxygen requirements of the various retinal layers and of the diffusion constant of oxygen through them, it is not possible to establish this point by quantitative calculations[9]. However, Wagenmann[10] showed that the outer layers depend mostly on the choriocapillaries for their nutrients. On this basis, if we take it that these layers receive a sufficient oxygen supply from the choriocapillaries alone, the supply should also be adequate for the whole of the fovea—since the capillary-free part of the fovea is little or no thicker than the outer retinal layers at the edge of the yellow spot.



Distribution of capillaries and of yellow pigment in the macular region

On the left, the areas containing capillaries are shaded with diagonal lines (*C*, *C*). This shading does not bring out the fact that there is a dense sheet of capillaries in the choroid next to the outer retinal layers[11], while capillaries are more sparsely distributed in the inner layers[8,12]. On the right, vertical shading gives a rough indication of the pigment concentration. The outer retinal layers are denoted by *OO* and the inner layers by *I*. Dimensions and yellow pigment distribution after Schultze[5] (compare with Polyak[13]). Size of capillary-free area according to Weale[7]

In any event, while a pigment in the retinal tissues could store oxygen, it is not clear how it could increase the *rate* of supply of oxygen to them under the *steady-state* conditions which must generally prevail in daylight.

E. J. DENTON
M. H. PIRENNE

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Marischal College,
University of Aberdeen.
Nov. 25.

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[1] Dartnall, H. J. A., and Thomson, L. C., *Nature*, **164**, 876 (1949).

[2] Fick, A., in Hermann's "Handbuch der Physiologie", **3**, Pt. 1, 182 (1879).

[3] Shlaer, S., Smith, E. L., and Chase, A. M., *J. Gen. Physiol.*, **25**, 553 (1942).

[4] Wald, G., and Griffin, R. D., *J. Opt. Soc. Amer.*, **37**, 321 (1947).

[5] Schultze, M., *Arch. mikr. Anat.*, **2**, 175 (1866).

[6] Polyak, S. J., "The Retina", 198 (Chicago, 1941).

[7] Weale, R. A., quoted by Dartnall and Thomson, ref. 1. In the latter paper, 1° 30″ is a misprint and should read 1 degree 30 minutes (personal communication from Dr. Dartnall).

[8] Polyak, ref. 6, p. 207.

[9] Hill, A. V., *Proc. Roy. Soc.*, B, **104**, 39 (1928–29).

[10] Wagenmann, *Arch. f. Ophth.*, **36** (4), 1 (1890), quoted in Duke-Elder, ref. 11, p. 481.

[11] Duke-Elder, Sir Stewart, "Textbook of Ophthalmology", **1**, 55 (1932).

[12] Duke-Elder, ref. 11, p. 142.

[13] Polyak, ref. 6, p. 447.

IN their letter in *Nature* of November 19, Dr. Dartnall and Dr. Thomson advance the view that the macular pigment plays the part of an oxidation-reduction system in the human macula and fovea. I do not feel that a satisfactory case has been made out for the existence of this pigment at the fovea ; nor for the need for an auxiliary oxygen-carrying system.

(1) Dartnall and Thomson do not refer in their letter to the fact that the retina has a double blood supply : a superficial supply by means of the retinal vessels, and a deep supply by means of the choroidal vessels. The former consists of a coarse net of narrow bore blood vessels with few widely spaced capillaries. The latter consists of a dense feltwork of blood vessels which supply arches of capillaries so closely meshed that few parts of the adult human body present a similar picture. In consequence, these vessels provide the outer side of the retina with a blood supply of a richness probably not exceeded anywhere else. Thus the statement which Dartnall and Thomson make is true, namely, that there are no retinal vessels at the foveal centre. But the

inference they draw, that in consequence of this there should be a relative shortage of oxygen, is open to grave doubt unless it can be shown that the choroidal blood supply is either deficient, or absent, at this part of the retina. Such is not the case, however, because Wolff, in his "Anatomy of the Eye and Orbit", writes on p. 70: "The number of vessels in the macular region is much greater than elsewhere, so that here in a well injected specimen an almost inextricable mass of vessels of various sizes is seen". Thus an oxygen deficiency of the fovea is unlikely because of the generous compensatory blood supply provided by the choroid, and because of the thinness of the retina in this situation.

(2) According to Dartnall and Thomson, it would be expected that a shortage of oxygen would cause blindness at the fovea, but little effect at other parts of the retina, whereas, in fact, the opposite is found to be the case, and they suggest that this points to the presence in the fovea of a special biochemical system for the purpose of assisting oxidation by raising the oxygen tension. Three comments may be made on these suggestions: (*a*) that oxidation-reduction systems do not raise oxygen tension, but only enable the oxygen which is available to be employed with greater efficiency; (*b*) that such biochemical systems may help to deal with an oxygen shortage, but cannot assist either with the other shortages of substances needed for purposes of metabolism, or with the accumulation of waste products, which probably more than anything else adversely affect tissues which are suffering from a reduced blood supply; (*c*) that an alternative and more likely explanation is available as follows: the retinal sense cells, the rods and cones, are quite close to the choroidal capillary network, and are relatively a long way from the retinal capillaries. It seems likely, therefore, that the latter are more concerned with the nutrition of the nervous structures, which are close to them, particularly the ganglion cells and optic nerve fibres. Now light rays on their way to the receptor cell-layer have to pass partly in between the vessels, and partly through the walls of the vessels themselves. Therefore, in order to avoid an unnecessary loss of light, it seems likely that these vessels have been reduced as far as possible both in number and diameter, so that they provide for the metabolic needs of the nervous structures, but no more. Thus any interference with the blood flow through these vessels would be expected to affect the nutrition of the nervous structures. Now the nerve fibres which connect the peripheral parts of the retina with the optic papilla, where the nerve fibres turn to emerge from the eyeball, are much longer than those which connect the fovea and the macula with the papilla. It would therefore be anticipated that an interference with the retinal blood supply would affect the long peripheral fibres, but might permit the short central ones to escape, as is found to be the case.

On these grounds it does not appear necessary to assume that the escape of the central part is due to the presence of some special biochemical mechanism which is not found elsewhere in the retina.

(3) In the course of my duties as a teacher to medical students, I have examined closely the fresh retinas of many animals. Yet never once do I remember seeing macular or foveal pigment. I have seen many human retinas which showed no macular pigment either; and I have also seen some human retinas which showed some pigment, but in the latter cases the pigment could be accounted for as being due, either to pathological changes during life, or to post-mortem staining after death. This is in conformity with the ideas of Gullstrand, who held the view that macular pigmentation is a post-mortem effect, and with those of Wolff (1948), who wrote on p. 103 of his book: "The yellow colour of the macula is best seen in post-mortem eyes in which the retina has already become clouded. It is not seen in perfectly fresh eyes, nor ordinarily with the ophthalmoscope".

With regard to the latter, it has been stated that the macular pigment can be seen when red-free light is employed in conjunction with an ophthalmoscope. In fact, what is observed is that the fovea has a slightly different tint from the rest of the retina, and this might be due either to absence of blood vessels, or to the greater thinness of the retina at the fovea, thus disclosing more clearly the underlying colour of the choroid; or to some other factor. No proof has ever been given that the difference is due to macula pigment.

Sometimes subjective evidence is put forward in favour of foveal pigmentation. This is of several different kinds; that when three colours, say, red, green and blue, are mixed in various proportions, in order to match the spectral colours in turn, then different observers are found to require different proportions of these colours, and this is claimed to be evidence for the existence of macular pigment which is said to be present to a greater extent in some people than in others. Now Wright employed a method of presentation which would eliminate the effects of macular pigment, if any were present; but even then, differences in the proportions of the three matching colours were still found to occur, thus clearly demonstrating the fact that some other explanation must be looked for. Another type of experiment is one in which a uniform purple field is looked at, whereupon most observers see for a short time a pink spot which coincides with the centre of the fovea. This coloured spot is stated to be due to the absorption of the blue component of the purple light by the yellow macular pigment, thus permitting the red component to be observed by itself. Two comments may be made: In the first place, why is the pink spot seen for so short a time, and is it because the macular pigment undergoes rapid bleaching? In the second place, why is the pink area a dot; should it not be a ring in view of the fact that, when pigment is present in post-mortem eyes, it is not found at the foot of the foveal pit but in the sides of the slopes which lead up to the macular plateau?

(4) Lastly, as evidence of foveal pigment, Dartnall and Thomson mention the so-called tritanopia, or blue blindness of the fovea.

Many experiments have convinced me that there are sharply localized differences between one part of the retina and another. In addition, it is well known that more general differences occur. Thus the colour vision of the peripheral retina differs from that of the central retina. But in one respect all parts are alike, namely, in becoming both yellow-blind and blue-blind when a reduction is made either in the light which illuminates a coloured object, or in the visual angle which that object subtends at the observer's eye. Thus a large test object measuring 50 cm. × 30 cm., consisting of alternating parallel blue and yellow bars, 6 mm. wide, is found, in average daylight, to lose all colour and to appear black and white when it subtends at the eye an average angle of about three degrees. By fixing in turn objects situated around this test object, it is possible to test other parts of the retina in addition to the fovea and macula. In this way it can be shown that the loss of colour takes place everywhere, showing that normal colour vision has been replaced by dichromatic vision. If then it be true, as Dartnall and Thomson suggest, that these colour defects are due to macular pigment, the conclusion must be that this pigment is present everywhere, and is not found solely at the macula. Now the effects of macular pigment on colour vision can be tested easily by placing a suitable yellow colour filter in front of the observer's eye. When this is done, blue is replaced by black, and in this respect the effect of reducing light intensity and visual angle is imitated. But in the case of yellow the imitation is found to fail, because instead of yellow becoming pale grey or white, as it does when its intensity or its visual angle is reduced, it is found to remain unchanged when it is viewed through the yellow filter. There is also another difference: white paper remains white with a reduction either of visual angle or of light intensity, whereas it alters to yellow when the yellow filter is used. The conclusion is that a yellow pigment cannot be responsible for the changes in colour vision which are observed at small visual angles and at low light intensities.

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Dec. 7.

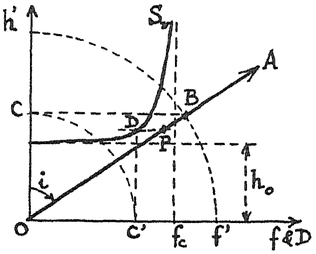

Fig. 1

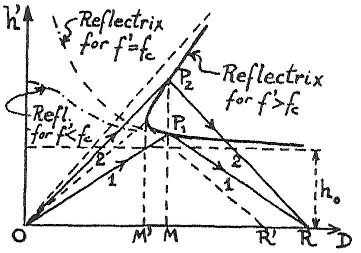

Fig. 2

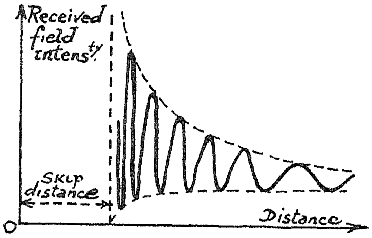

Fig 3

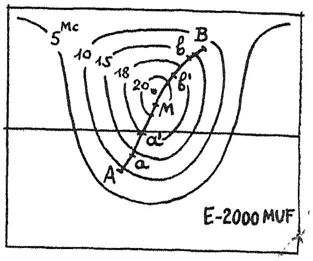

Fig. 4

FIELD INTENSITY AT THE RECEIVER AS A FUNCTION OF DISTANCE

Effect of the Ionic Distribution on the Unabsorbed Field Intensity as a Function of the Distance to the Transmitter

By P. LEJAY and D. LEPECHINSKY
Bureau Ionosphérique Français

FROM the characteristics of the reflecting layer defined by the $h'f$ trace (S_0 in Fig. 1), it is possible to determine graphically the virtual path followed by a wave reflected by the ionosphere. Let us superpose on the f scale of the graph a second scale, identical to the vertical one, representing distances from the transmitter O. A wave, leaving the transmitter with an angle i, follows the path OA, which intersects at B the circle drawn with Of' as a radius. Projecting OB on the h'-axis and taking on the x-axis OC' equal to OC, we get on the f-scale a frequency $OC' = OC = OB \cos i = f' \cos i$. According to Martyns's theorem, the virtual height of the reflexion point of the f'-wave following the path OA is equal to that of the frequency OC' leaving the transmitter under normal incidence on the layer. The $h'f$ trace shows that this height is $C'D$; the point of reflexion will therefore be in P.

Repeating the same procedure for different angles i, one finds that reflexion points P form a continuous curve (which we shall call the 'reflectrix'), in the vertical plane considered, assuming the form of an inclined V with a horizontal branch when $f' > f_c$, and being like a dome overhanging the transmitter when $f' < f_c$.

It is seen immediately from Fig. 2 that $OR' = 2\,OM'$ is the skip distance; it is easy to measure the angles i for the two possible paths when $f' > f_c$ for distances greater than OR'; and one can recognize on a similar figure the only possible path when $f' < f_c$.

The earth and the ionospheric layer have been supposed flat. In the case of curved earth and curved ionosphere, the procedure is more laborious; but the reflectrix can nevertheless be found easily with fairly good approximation with the aid of the well-known 'transmission curves' of the standard method for obtaining the maximum usable frequency.

The reflectrix being known, it is easy to draw the curve denoting the variation of OR when the angle i varies from 0 to 90°, and the curve representing the variation of the spherical surface swept by the arc OR (in the case of the curved earth) when rotating around the vertical Oh', as a function of the angle i. Now, the transmitter being supposed isotropic, the power radiated in a cone having a vertical axis and an angle i is proportional to the corresponding solid angle. Thus one can read on the curves the increase of power ΔP and the increase of surface ΔS receiving the radiated power for an increase Δi. The ratio $\Delta P/\Delta S$, the power density resulting on the ground, will then be determined graphically.

This method shows very simply that the variation of the received field intensity is far from obeying the simple inverse distance law. In fact, there is a focusing effect not only at a distance corresponding to the path that leaves the transmitter tangentially to the earth surface (an already known fact) but also *at the limit of the skip distance.*

This is due to the fact that the field intensity is not only a function of the distance but also of the slope of the reflectrix at the point of reflexion and of the angles of departure i and of incidence i' on the ionosphere. In other words, the received field intensity depends on the frequency and on the height and ionization gradient of the reflecting layer.

It can be shown[1] that the power density received at ground-level on a plane surface normal to the wave-path considered is given by:

$$d_n = -\frac{P \operatorname{tg} i}{4\pi R^2 [\sin D/R] \times \dfrac{\operatorname{tg}\beta(\operatorname{tg} i - \operatorname{tg} i')}{\operatorname{tg} i(\operatorname{tg} i' + \operatorname{tg}\beta)}},$$

P being the total radiated power by the point-like isotropic radiator, R the radius of the earth and β the slope of the reflectrix in degrees.

Unabsorbed received field intensity can be computed in the same way for a multi-hop path. It is found that, in the case of a perfectly reflecting ground, when the reflectrix is almost parallel to the ground the energy may be received by an infinite number of paths and the field intensity may be almost double that due to a single hop mode.

We have represented in Fig. 2 the two paths followed by the waves to reach a point beyond the skip distance when $f' > f_c$. These waves reaching the receiver being out of phase, one can expect maxima and minima of the received field along the great circle passing through the transmitter and the receiver. It can be shown that these maxima and minima are quite close to each other near the skip zone limit and tend to be more and more distant from each other with increasing distance from the transmitter. Received field intensity is represented as a function of distance from the transmitter in Fig. 3.

This seems to indicate that even a slight alteration of the ionization or height of the reflecting layer is able to cause a serious fading at a point not too distant from the skip zone.

[1] Note préliminaire, Laboratoire National de Radioélectricité, No. 121 (October 1948).

'M-Mode' Propagation Possibilities

By D. LEPECHINSKY

Bureau Ionosphérique Français

THE E-layer ionization depending almost exactly on the sun's angle of elevation, the usual E-2.000-MUF (maximum usable frequency) charts are formed of contours of equal frequency surrounding the subsolar point (see Fig. 4).

Let us consider a radio communication great-circle path between points A and B. At the hour corresponding to the position of the path AB shown in Fig. 4, the ion density of the E-layer is a maximum near the middle of the path and decreases towards its ends. In these circumstances, a wave of a sufficiently high frequency leaving the transmitter A at oblique incidence penetrates the E-layer at a, is reflected by the F_2-layer at a', then comes down on the E-layer at M, but being unable to penetrate it there because of the higher ion density of the E-layer at this point, is reflected back to the F_2-layer, which reflects it down again at b'. The wave then penetrates the E-layer at b, where the ion density is almost the same as at a, and reaches finally the receiver B. This mode of propagation is called a two-hop 'M-mode'. Multi-hop M-modes over-ride the E-layer in a similar way.

The chief advantage of these modes is the low attenuation suffered by the wave that follows them.

One can expect 'M-modes' to be particularly effective on long-distance transmission paths entirely situated in daylight, when normal field intensity at the receiver is low because of severe attenuation of normal multi-hop communication due to ground-reflexion losses and to high absorption in the D-region, which has to be traversed several times by the wave before it reaches the receiver.

A practical method of prediction of the rather narrow frequency band normally propagated by the 'M-modes' and of the corresponding rather short intervals of time can easily be devised. A set of auxiliary curves permits the rapid location, on the great circle path joining the transmitter to the receiver, of both D-region penetration points and of the intermediate 'upper' reflexion points on the E-layer. A simple method of computation of the received field intensity and thus of the gain due to the 'M-modes' is also easily devised. Predictions of 'M-mode' propagation are now worked out by the Bureau Ionosphérique Français[1].

Outstandingly good reception obtained regularly in March 1949 at about 7 00 a.m. (G.M.T.) on about 19 Mc./s. between Saigon and Tananariff (Madagascar) and in May 1949 at about 6 00 a.m. (G.M.T.) on about 14 Mc./s. between Paris and Numea (New Caledonia), seem to be in close agreement with 'M-mode' predictions by this method for these transmissions.

Focusing effects and 'M-mode' propagation thus appear to have an important influence on the field intensity at the receiver, and it is felt that it is no longer permissible to neglect them in prediction work.

[1] Note préliminaire, Laboratoire National de Radioélectricité, No. 130 (May 1949)

AGE-GROUPING OF TSETSE-FLIES AS AN AID IN THE STUDY OF THEIR BIONOMICS

By F. A. SQUIRE

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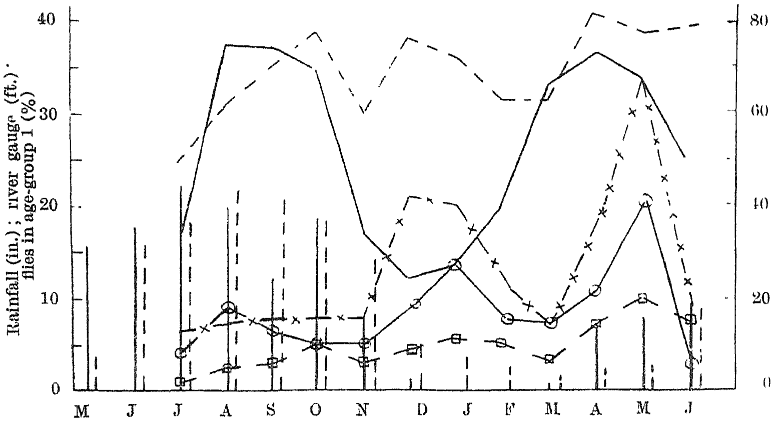
THE following observations on *Glossina palpalis* R-D were made in Sierra Leone at Njala on the River Taia about 8° 5′ N. and 12° 5′ W. during the period July 1948–June 1949. Some five thousand flies were collected and examined. As it was not possible in the circumstances to adopt Jackson's[1] more elaborate method, a simplified system of age-grouping was devised. The catches were classified into three age-groups according to wing tear and colour: $AG1$ smoky wings; $AG2$ wings turning tawny; $AG3$ wings tawny and frayed. Monthly summaries were made and the percentage of flies in each age-group calculated; the ratio male/female (R) was recorded separately for each age-group; the total number of flies per man-hour (H) estimated; and the number of unmated females (V) was noted and expressed as a percentage of the females in $AG1$. The results are summed up in the accompanying table and graph.

Considering first the percentage of flies in $AG1$, it will be seen that emergence must continue fairly



Vertical unbroken ordinates, rainfall; vertical broken ordinates, river gauge, - - - -, percentage of flies in age-group 1; ———, percentage of unmated females; □—□--, male/female ratio in age-group 1; × — × —, male/female ratio in age-group 2; o--o--, male/female ratio in age-group 3

actively all the year round, since *AG*1 is never less than 24·8 per cent. Thus the widely accepted and not unreasonable belief that emergence ceases when the puparial sites are inundated appears to have no foundation in fact. The lowest value was recorded in July, when the river had by no means attained its highest level, and the value was actually on the increase in August and September when the riverine puparial sites were covered. The highest value, 41·1 per cent, was recorded in April at the beginning of the rains. The mean monthly figure was 34·4 per cent, so that seasonal differences are not very pronounced.

A more satisfactory measure of the rate of emergence is the number of unmated females, V. Nearly all females are mated within a few days of emergence, judging by the fact that practically all unmated flies are extremely teneral. Unmated females are readily distinguishable by the absence of mating scars. It will be seen that there are two peaks of emergence: during the wettest, and again during the hottest if not driest months. The lowest values are recorded in December–January, two of the driest months owing to the cessation of the rains and the prevalence of that dry, desert wind, the Harmattan; and again in June–July, two months of high rainfall. The rainy season emergence peak is of special interest since it raises the question: Where do the flies emerge? The riverine puparial sites are by this time several feet under water. There are three alternatives: the pupæ remain viable and the flies emerge through the overburden of water; the puparia are dislodged and washed up on the riverine beaches where they hatch; the fly anticipates events and larviposits in extra-riverine sites. The last is probably the true explanation.

Monthly summary of flies collected

Month	*AG*1		*AG*2		*AG*3		H	V	Total
	%	R	%	R	%	R			
1948									
July	24·8	0·9	53·1	2·5	22·1	1·7	1·9	31·6	145
August	30·4	1·2	53·7	2·8	15·9	3·7	2·7	75·4	415
September	34·8	1·5	51·5	3·0	13·7	2·7	2·8	75·0	431
October	38·6	2·4	43·7	2 8	17·7	2·1	2·1	69·9	345
November	28·9	1·5	48 8	3·1	22·3	2·1	1·9	33·3	360
December	38·1	1·9	44·5	8·3	17·4	3·8	2·0	25·0	441
1949									
January	36·0	2·3	41·4	8·0	22·6	5·4	2·2	25·8	283
February	31·6	2·2	49·4	4·8	19·0	3·1	3·5	39·7	398
March	31·5	1·7	49·6	2·6	18·9	3·1	3·9	66·0	397
April	41·1	2·6	41·8	7·2	17·1	4·4	5·2	74·0	909
May	38·5	3·4	49·5	13·6	12·0	8·2	7·6	67·6	384
June	38·7	2·9	45·0	3·7	16·3	1·4	2·7	50 0	271

In order to understand this periodicity of emergence, it is necessary to study the gestation cycle. This is represented by the ratio male/female R, in *AG*1, *AG*2 and *AG*3, since pregnant females are more chary and therefore comparatively rare in catches. R shows the greatest variation in *AG*2, the procreant group *par excellence*, somewhat less in *AG*3, and least in *AG*1, which consists of young flies up to about fifteen days old. It will be observed that the ratio is low throughout the rains, and it may be concluded from this that conditions at this time do not greatly favour gestation. The hot dry months of February and March again adversely affect gestation, while the most favourable seasons appear to be May and December, that is, at the beginning and at the end of the rains. Allowing for the time-lag due to the maturation of the larvæ and to the pupal period, it will be seen that the gestation peaks in December–January and in May probably result in the emergence peaks of April and August respectively. It may be objected that seasonal food scarcity might cause even pregnant females to flock to the 'fly-boys'. This factor is not judged to be appreciable in Sierra Leone, where the food supply, though not abundant, is static.

Comparing R in the three age-groups, it will be seen that they all follow the same seasonal trend, and that R is almost consistently highest in *AG*2 and lowest in *AG*1. The frequent references in literature to the ratio male/female ignoring the age of the flies may therefore be very misleading. *AG*1 being the least procreant of the age-groups, it is not surprising to find that R here is consistently the nearest to the true natural ratio of unity. In theory, it may be assumed that when $R = 1$ there is no gestation in progress. In practice, this is not necessarily so, for there will always be some pregnant females that will be caught, thus reducing the value of R. At the other extreme, it would be unwise to assume that the highest value of R recorded, namely, 13·6, represents 100 per cent pregnancy. If then $R = 1$ is assumed to represent, say, 5 per cent pregnancy, the highest gestation-rate recorded in terms of pregnant females would be, in May: *AG*1, 17; *AG*2, 68; *AG*3, 41 per cent of the females in each age group; and the lowest, in July: *AG*1, 4; *AG*2, 12; *AG*3, 8·5 per cent.

The number of flies caught per man-hour (H) given in the table revealed but little variation, and is not shown in the graph. The highest average monthly figure (7·6) was recorded in May, and the lowest (1·9) in November. There was a second peak in September (2·8). Thus the peaks coincide with the peaks of unmated females (V). This poor rate of collection of flies is characteristic of the general low numerical status of *Glossina palpalis* in Sierra Leone.

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[1] Jackson, C. H. N., *Bull. Ent. Res.*, 37, 2; 39, 3.

HISTORICAL CHEMISTRY COLLECTIONS AT THE UNIVERSITY OF ST. ANDREWS

A VALUABLE gift of more than eighty books dealing with historical chemistry has recently been made to the library of the Chemistry Department, United College, University of St. Andrews, by Dr. Leonard Dobbin, the doyen of Scottish chemists and a leading authority on the history of his science. Many of these books are rare, and the addition will strengthen notably one of the outstanding collections of the kind in Great Britain. Besides a reference section in constant use by research students and members of the chemistry classes, this departmental library contains a collection of great interest, comprising books, manuscripts, holograph letters, portraits, engravings, and even a few paintings, dealing with alchemy and historical chemistry. The oldest manuscript is a Latin collection of early treatises on alchemy, of the fourteenth century, and there is a fine copy of the first printed work by any Scots man of science—the "Physionomia" of Michael Scot, published in Venice in 1477.

Among other items are some holograph writings on alchemy by Sir Isaac Newton, and an unusually complete set of the alchemical books of Count Michael Maier, "the musical alchemist of Prague". There is also a handsome copy of Agricola's "De Re Metallica" (Basle, 1561), bearing the signature of the second professor to hold the chair, M. F. Heddle, by whom it was bound in leather; this book came back to the Department in a romantic way in 1931. A set of John Dalton's "New System of Chemical Philosophy" bears an inscription in the author's handwriting to his friend, Dr. Joseph Ransome.

Of the total of nearly three thousand volumes in this library, about one-third belong to the historical section. An original small nucleus consisted of books formerly belonging to Prof. Arthur Connell, the first occupant of the chair (1840–62); but most of the items have been acquired during the term of office of the present incumbent, Prof. John Read. Many of them have been described in Prof. Read's recent trilogy of historical works, "Prelude to Chemistry", "Humour and Humanism in Chemistry" and "The Alchemist in Life, Literature and Art". Owing to the cramped accommodation in the Department, it is impossible to do justice to these collections of books, etc., which call urgently for safer housing and an effective system of display. During the past few years a connexion has been established between this library and the Edgar Fahs Smith Collection in the University of Pennsylvania, and Prof. Read has become associate editor of *Chymia*, an annual publication devoted to historical chemistry and emanating from the University of Pennsylvania.

The St. Andrews collection is supplemented by more than two thousand lantern slides, many of which deal with historical chemistry and have been reproduced from original sources. Cognate research collections illustrate by means of original specimens the investigations that have been carried out in the Department, since the days of Purdie, in the fields of stereochemistry, carbohydrate chemistry and terpene chemistry; and there are also some items of Australian interest. In addition, the library contains a balance of 1750 with a 37-inch beam, and a collection of chemical apparatus dating from the days of Black and Priestley in the latter half of the eighteenth century. This apparatus, found in the ancient tower of St. Salvator's Chapel about 1925, includes crucibles, earthenware retorts, glass alembics, a magnificent glass matrass six feet in height, and other items. It is likely that this apparatus was bought in 1811 from Dr. Thomas Thomson, another historian of chemistry, who disposed of a good deal of chemical apparatus to the University of St. Andrews when he resigned his chemistry lectureship at Edinburgh in that year.

AMSTERDAM CONFERENCE ON ION SOURCES

MORE than fifty people, including visitors from Belgium, France, Great Britain, Sweden and Yugoslavia, attended a Conference on Ion Sources which was held in the Zeeman Laboratory in Amsterdam during November 15–16, 1949. Prof. C. J. Bakker, director of the Dutch Institute for Nuclear Physics, opened the Conference, warmly welcoming the foreign participants, and briefly surveying the general problems in ion-source design and operation.

The first speaker, Dr. P. C. Thonemann (Oxford), described the development work on the high-frequency ion source. The principal points discussed included (*a*) the space-charge flow of ions through a metal canal, (*b*) production of a high concentration of atomic gas in the discharge space, and its relation to the proton percentage in the ion beam, (*c*) the extraction and focusing of ions into a canal, and (*d*) the energy inhomogeneity of the ions. Ion currents of 1 m.amp. containing more than 90 per cent protons have been recorded. The paper was illustrated by slides.

Experiments performed with ion sources of the Finkelstein and Penning type were dealt with by Mr. P. V. Veenstra (Utrecht). The discharge current varies with both the anode potential and magnetic field. The position of the maximum current depends only on the anode potential, and its magnitude varies with pressure. If the gas pressure is increased from a low value, a point is reached at which the slowly increasing discharge-current jumps to about five times its initial value. A similar phenomenon occurs with increasing magnetic field. On reducing either pressure or magnetic field, a marked hysteresis is observed. The condition of large discharge-currents Mr. Veenstra termed "the super state", and he reported strong high-frequency oscillations in this state. From both sources he reported currents of about 1 m.amp. (50 per cent protons). Dr. Thonemann suggested that the initiation of the 'super state' corresponds to the formation of a plasma at a potential positive to the cathode. Bombardment of the cathode by positive ions thus enhances the electron emission, and the discharge then shows all the characteristics associated with the low-voltage arc.

In the afternoon short papers were read. Mr. R. Björnerstedt (Stockholm) reported experiments on a Zinn-type ion source and the precautions necessary to obtain an unambiguous measure of the ion current. It has been noticed that the focused ion currents show a dependence on the probe material. Major E. Thomas (Brussels) read a paper on a high-frequency ion source under construction for a cascade generator of 1·4 MeV. Mr. M. E. Reinders (Amsterdam) pointed out that in the Nier-type source used in his mass spectrometer the electron beam forms a potential trough which may prevent molecular ions escaping while atomic ions, formed with considerable kinetic energy, escape readily. Thus maximum currents of H^+ and D^+ are obtained with electron currents of 500 µamp., whereas the molecular ion currents of H_2^+ and HD^+ are a maximum for currents of 1 µamp. This discrimination must be considered when, for example, the relative abundance of hydrogen and deuterium are being compared by the atomic ions. The difference in the nuclear separation of diatomic hydrogen and deuterium leads, on dissociation by electron bombardment, to different kinetic energies of the monatomic ions. The same afternoon the Laboratory for Mass Spectrography was visited, and the magnetic ion source of the Heil type was demonstrated. A 180° isotope separator (100-cm. radius) is under construction.

On November 16, Dr. M. Hoyaux (Charleroi) read a paper on "Cyclotron Ion Sources". After reviewing the earlier types of sources, he discussed in some detail the physical and mathematical problems associated with the adaptation of the Von Ardenne-type source for use in a cyclotron. Using as a basis the Broullin theory of the magnetron, he sketched the extension necessary to include the effect of gas collisions on the radial electron density and potential distribution. Theoretical work on the extraction mechanism is being pursued. Experiments at Charleroi on high-frequency ion sources for cyclotrons are due to begin.

The next speaker, Dr. J. Kistemaker (Amsterdam), discussed "Physical Problems in High-Intensity Ion Sources". He divided the subject into three main problems: (*a*) Production of ions in the discharge: for a given filament emission current, a maximum number of ions can be produced by choosing the correct accelerating voltage and increasing to a maximum the total electron path (for example, an oscillating electron source using an axial magnetic field). (*b*) Transport of ions to the exit opening: the potential distribution in the discharge must be such that the ions converge towards the exit opening and are drawn from a volume of intense ionization. (*c*) Extraction of ions: the ion currents are limited by space charge, and sufficient ions must drain towards the exit opening so that penetration of the extracting field into the discharge is not sufficient to extinguish it. Various questions of gas economy were discussed. An ion source has been constructed in which 50 per cent of the total flow through the exit opening are ions. At a gas pressure of 6×10^{-5} mm. of mercury and an extraction voltage of 8 kV., 6 m.amp. of helium ions were measured passing through an exit 1 cm. in diameter.

In the afternoon, Dr. C. Cassignol (Paris) discussed the "Extraction and Focusing of Ion Beams". He mentioned a promising type of magnetron ion source consisting of two short concentric cylinders in which the outer is the anode and the inner a perforated cathode. Due to the extended electron paths, intense ionization is produced at low pressures, and part of the ion current passes through the cathode and is extracted in an axial direction. Experimental results are not yet available. Some interesting information about the operation of the ion source in the Nier isotope separator was given by Dr. R. Bernas (Paris). He has observed that with increasing magnetic field the initial ion current (2 m.amp. focused beam) suddenly drops practically to zero while the probe and discharge current both increase. It is suggested that a sudden transition to a 'super state' completely altered the previous condition in this source, and the ion beam issuing from the exit slit was then widely divergent. Dr. P. M. Endt (Utrecht) then described some experiments on a pulsed Finkelstein source.

In the final talk of the session, Dr. H. Brinkman (Arnhem) suggested that very pure proton currents could be obtained by ionizing hydrogen in a tungsten cylinder maintained at 2,500° C. At sufficiently low pressures, dissociation of molecular hydrogen is practically complete at this temperature. An anode placed in the tungsten cylinder serves to accelerate the electrons. The Conference was closed by a visit to the 30-MeV. synchro-cyclotron in the Institute of Nuclear Physics. C. J. ZILVERSCHOON

EDUCATION IN BOLIVIA

ANOTHER of the series of basic studies on education in certain Central and South American countries has been prepared under the ægis of the United States Office of Education. The studies are part of a programme to promote understanding of educational conditions in the American countries and to encourage co-operation in the field of inter-American education. Begun in 1943, the project involves travel by Office of Education specialists in the various countries to gather first-hand information on their educational systems and the preparation of reports from these data for publication. "Education in Bolivia" is based on data gathered by R. H. Nelson in Bolivia in 1947 and supplemented since then through documentation (Washington, D.C.: Government Printing Office).

Situated in the west-central region of South America, Bolivia is one of the two countries in the western hemisphere without a sea coast or sea port. Its area is estimated at half a million square miles, which is roughly ten times the size of England. Two principal mountain ranges cross the country from north-west to south-east. Between these ranges lies the High Plain, the largest and highest plateau in the western hemisphere, from which Bolivia gets the popular name of the "Land in the Sky". To the east, in the lowlands of the Amazon and Parana Plain, lies a tropical and sub-tropical section which comprises almost two-thirds of the total area of the Republic. In the highland plateau and the valleys leading eastwards from it are located the largest and most important cities of the Republic, La Paz, Cochabamba, Sucre, Potosi and Oruro.

The climate ranges from tropical heat in the eastern section to arctic cold in the mountains and high plains of the west. In the valleys to the east the climate is temperate. In both these regions the soil is largely poor and thin, but supports a meagre agriculture which supplies in part the needs of the peoples of these areas. In the eastern two-thirds of the country the possibilities of agricultural production are rich, although at present this area is sparsely populated and virtually undeveloped.

The 1,400 miles of railways in Bolivia form a system which connects the principal cities. Road and railway construction are enormously expensive in the rugged mountain areas, and a serious defect in the transportation is the lack of road and railway connexions with the eastern lowlands. Two principal airlines render efficient service among the main cities.

Tin is by far the leading export of Bolivia, which produces 15 per cent of the world's supply. Other metals exist in the mountains of the Republic and represent potential national wealth. The principal agricultural products include coca leaves from which cocaine is made, cinchona bark, rubber, animal products (hides and wool) and nuts. There is little or no manufacture in the country. Nothing is produced for export, and only a small amount for domestic consumption.

Under the constitution of 1938 the Republic of Bolivia has a representative government of three branches. The executive power is vested in a president, elected by direct suffrage for four years, and his appointed cabinet. The legislative division consists of a bicameral congress with a senate and chamber of deputies. All men of twenty-one years of age who can read and write are privileged to vote.

Of the estimated 3½ million people who make up the population of Bolivia, approximately 1½ million are Indian, 500,000 are white, principally of Spanish descent, and the remainder are of mixed blood. The Indians have good physique and constitute a great potential asset to their country if their social status could be improved through education and legislation. About 80 per cent of the population inhabit the highland one-third of the country's area and contribute to the mining industry. According to recent estimates, 75 per cent of the people of Bolivia are illiterate; most of these live in rural areas where schools are not available.

The recognized national religion is Roman Catholic; but other religions are permitted. Spanish is the national language; but the Aymara and Quechua tongues are spoken by most of the Indian and mestizo portions of the population.

Before the coming of the Spaniards in the sixteenth century, the culture of the Aymara and Quechua Indians was preserved and handed on from one generation to the next by word of mouth. To-day, public education in the elementary, secondary, rural, vocational and normal schools is under the administration and supervisory control of the Minister of Education, Fine Arts and Current Affairs. The great problem of Bolivian education lies in the relationship between the country's financial ability and the enormous need for increased educational facilities. In 1943 it was estimated that only 23·8 per cent of the 600,000 children of school age (7–14 years) were in daily attendance at school. While it is true that educational facilities have improved since 1943, even at a most generous estimate far less than half the nation's children attended any school at all in 1948. The most hopeful aspect of this situation is the fact that the people of Bolivia are aware of the need for educational facilities and are making a progressive effort to find the solution to this problem.

In the rest of his report Nelson examines the different stages in Bolivian education in considerable detail; the following features should be of special interest to educationists.

The problem of school attendance, especially in the elementary school, is serious owing to such factors as lack of transportation, illness, necessity for students to work and parental apathy or irresponsibility towards the question of schooling. Much is being done through the medium of parent-teacher groups to bring about a realization of the need for education of young children. These parent-teacher groups are also making a serious effort to combat the prevalent idea that education is not as necessary for girls as for boys.

The traditional method of instruction in Bolivian schools, as in schools of some other Latin-American republics, involves dictation of factual material by the teacher and transcription of this material verbatim by the student into a set of carefully kept notebooks. Recitation is formal and stereotyped, the student being expected to stand when called upon and repeat verbatim the dictated material requested; free class discussion is not used as a method of instruction. The scarcity of text-books in Bolivian elementary schools is a serious handicap to teaching and especially to the teaching of reading.

Of the 309 urban elementary schools, thirty-four are night schools. A few of these are open to adults who wish to get an elementary education which they missed in their youth; but the large part of the night-school student body is made up of children who work during the day. Some of those who work on farms come from distances of ten or fifteen miles.

The only requirement for admission to a secondary school beyond the usual proofs of good health and good character is the completion of the six-year elementary school course. Despite this, the secondary school enrolment of 14,821 students is less than 8 per cent of the total school enrolment. Tuition in the public secondary schools is free, and the instruction is much the same as in elementary schools. This has the sanction of long usage and is considered the most practical method in view of the fact that almost no text-books or reference books are available.

Vocational education is a comparatively new development in Bolivian education, having first been introduced about 1942. Its inclusion in the school programme is thus still in an experimental stage. There are eight vocational schools for girls, seven industrial schools for boys and five commercial schools. In addition to these schools, four of the universities maintain institutes for certain types of technical training on the secondary level. These offer four years of training in mechanics, electricity, foundry and graphic arts. The stated object of the girls' vocational schools is to "complete the general education of women and to prepare them for the exercise of the manual occupations suitable to their sex".

Teacher training is carried out at various colleges, one of which, the National Teachers' School at Sucre, has operated continuously since its foundation in 1909. As part of the course in pedagogy and teaching methods, students are required to spend one hour per week during the third year of their course in observation of actual classroom teaching, and during the fourth year they are required to teach one hour a week for twenty-four weeks under the supervision of a methods instructor and a classroom teacher.

There are seven universities in Bolivia, all of which, as well as any which may later be created, constitute a national entity known as the Bolivian University. The aims and functions of the Bolivian University are as follows: "The Bolivian university will give impulse to the scientific investigation of university problems with the object of enriching the cultural patrimony of the university and it will especially undertake those national problems related to the development of the natural wealth of the country". As in other South American republics, the university congress includes student members.

T. H. Hawkins

SIZE AND DISTRIBUTION OF INCOME IN GREAT BRITAIN

THE Oxford University Institute of Statistics has reprinted five essays by Dudley Seers which appeared in the *Bulletin* during 1948*. They make a brave attempt to estimate some of the more interesting economic quantities, to calculate a non-working-class cost-of-living index, to use it to examine the changes in the distribution of the real national income, and to correct the national product estimates for price changes, so as to obtain comparative figures for the pre- and post-war allocations of productive resources between different uses.

Estimates are first obtained of middle-class (here used throughout to mean non-working-class) expenditure in 1938 by subtracting from the official estimates of total expenditure given in the National Income White Papers estimates of working-class expenditure derived from the 1938 Ministry of Labour cost-of-living inquiry. The results reveal some interesting discrepancies between the two estimates from the different sources, discrepancies which cannot be resolved owing to the official reticence about the method of deriving the 1938 White Paper consumption estimates. This seems a good example of the type of result which is often found when the results of a statistical inquiry are checked against other data.

The next essay is devoted to an attempt to discover the change in the working-class cost of living between 1938 and 1947 as calculated (but not published) by the Technical Committee on the Cost-of-Living Index. The third essay uses the weights obtained in the first essay to calculate the change in middle-class cost of living since 1938. Both indexes are brought up to date to September 1948. In the fourth essay an analysis of real changes in the national income, its uses and origin, is made for the war years. The last essay considers the use of the Interim Index of Retail Prices as an index of working-class cost of living at present and concludes that the errors involved in this procedure cancel each other.

The most important conclusions of the essays occur in the following two short tables.

	£ millions, at 1947 prices		
	1938	1947	Change
Working-class real income (net of taxes)	4,348	4,735	+387
Middle-class real income (net of taxes)	3,599	3,354	−245

CAUSES OF THE INCREASED NATIONAL DEFICIT

		£ millions (1947 prices)
Deficit in 1938		70
Effect of changes in terms of trade (including invisibles)		+300
Effect of changes in national outlay since 1938 :		
More private consumption	+100	
More investment (gross)	+330	
More military spending	+450	
More current government spending	+480	
	+1,360	
Effect of increased national production since 1938 :		
More production for home market	−1,780	
More exports of goods	−70	
Less exports of services	+800	
	−1,050	
Net effect of changes in outlay and production since 1938		+310
Deficit in 1947		680

Mr. Seers gives an estimate of the changes in industrial production between 1938 and 1946, here defined as the gross product of industry in the widest sense, including agriculture and commerce, transport and the entertainment industry. The fourth essay indicates an increase of output of 8 per cent, accompanied by an increase of 9 per cent in productivity per man-year. This may be compared with the decrease of 4 per cent indicated by the official index of production over the same period (using the comparable 1946 weighted index), and the decrease of 2 per cent recorded by the London and Cambridge index over the same period. The difference between these results are presumably largely due to differences of coverage.

The margin of error attached to most of the results obtained is obviously large. They are probably the best estimates available with the present sources, and the economist is indebted to Mr. Seers and the Institute for producing them in this collected form. They do, however, direct attention to an outstanding gap in the economists' statistical information. More facts are urgently required on the spending and saving behaviour of the middle and upper classes. This can only be achieved by carrying out sample inquiries, which with advantage might be arranged to cover all the social classes and to obtain information on total expenditure in a form suitable for comparison with retail trade statistics.

J. D. SARGAN

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* Changes in the Cost of Living and the Distribution of Income since 1948. By Dudley Seers. (Oxford University Institute of Statistics.)

INDIAN LAC RESEARCH INSTITUTE

ANNUAL REPORT FOR 1947-48

THE annual report for 1947–48 of the Indian Lac Research Institute, stationed at Ranchi, Bihar, has been issued from Namkum, Ranchi, dated 1949. The Institute has been suffering from want of several items of supply, among which are chemicals and apparatus which, as former annual reports show, have been in deficit for some time. This want is proving a severe handicap to the Institute, in which many people are interested, for a number visited it during the year.

A certain amount of training is given to students both in the industrial uses of lac and in the important methods of cultivation. Since the early days of lac production in what was the old Chota Nagpur Division, lac has certainly made a very considerable advance. It is interesting to note that in the early days of inquiry towards the end of last century and the beginning of the present, very little was known about the insect pests attacking lac or the most suitable methods of pruning, and seasons to prune, such good lac trees as *Palas, Butea frondosa* and the *Schleichera trijuga*. A great advance has been made in these investigations at the Ranchi Institute. Some of the anti-insect investigations are of very considerable interest. It is said that sugar cane, cotton, pea, brinjal, hibiscus and maize were grown in a small area to obtain larvae of the lepidopterous pests from these plants for use as alternative hosts for laboratory breeding. Useful work has also been done in the chemical section.

As a result of an inquiry from a firm in Calcutta, experiments were undertaken with the view of utilizing photographic film scrap in combination with shellac for producing suitable spraying or brushing lacquers. It was found that a lacquer containing about 20 per cent of the film scrap on the weight of lac gave films of good clarity, gloss and hardness, but the water resistance of the film was low.

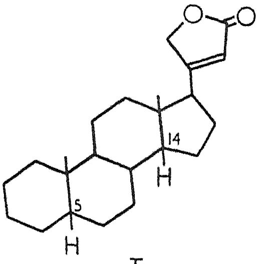
LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Nomenclature of the Cardiac Aglycones, Toad Poisons and Steroid Sapogenins

THE nomenclature of these groups of steroids is at present unsatisfactory. The trivial names tell the reader nothing about the structure of the compounds, and many names are so similar as to be confusing even to workers familiar with the substances, for example, digoxigenin, digitoxigenin, digitogenin. The systematic names of the aglycones based on the names of the bile acids are very lengthy and are rarely used—digoxigenin, for example, may be called 3α : 12β : 14 : 21-tetrahydroxy-14-*iso*-*nor*chol-20(22)-enic acid lactone (23 → 21) ; but the name is scarcely convenient. Since much work is being done on these compounds at present, and since steroid nomenclature is to be discussed at the next meeting of the International Union of Chemistry in 1951, it seems appropriate to offer some proposals for the systematic nomenclature of these compounds.

It is suggested that new names should be introduced for a few fundamental structures, and that the naturally occurring substances and their derivatives should be named as substitution products of these. (In these notes the indices α and β are shown without parentheses, following the suggestions of Fieser and Fieser[1].)



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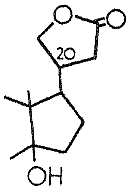

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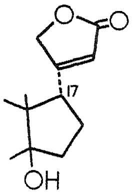

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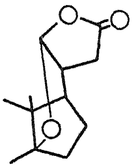

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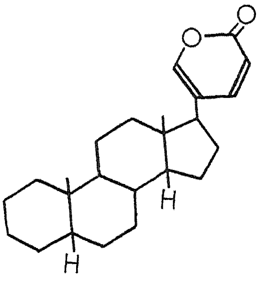

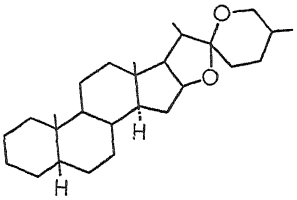

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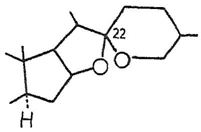
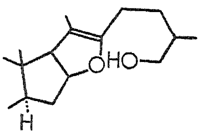
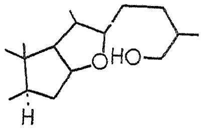


VII



VIII



IX

Cardiac aglycones. Most cardiac aglycones are derivatives of the 14-*iso*-*nor*cholenic acid lactone I, which might be called *digitenolide*—indicating the source of the compounds and their unsaturated lactone character. Digitoxigenin would then be named 3β : 14β-dihydroxydigitenolide ; its analogue odorigenin B (= uzarigenin ?) (Rangaswami and Reichstein[2]), which has the 5-*allo* configuration, would then be 3β : 14β-dihydroxy-5-*allo*-digitenolide. For further examples, see Table 1.

Table 1. PROPOSED SYSTEMATIC NAMES FOR SOME CARDIAC AGLYCONES AND TOAD POISONS

(Proposed name = prefix + stem name ; for example, strophanthidin = 3β : 5β : 14β-trihydroxy-19-aldodigitenolide)

Stem name :	Digitenolide	Bufadienolide
Prefix		
3β : 14β-Dihydroxy	Digitoxigenin	Bufalin
3β : 5β : 14β-Trihydroxy	Periplogenin	Telocinobufagin
3β : 11α : 14β-Trihydroxy	Sarmentogenin	Gamabufotalin
3α : 12β : 14β-Trihydroxy	Digoxigenin	—
3β : 14β : 16-Trihydroxy	Gitoxigenin	—
3β : 14β-Dihydroxy-16-acetoxy	Oleandrigenin	Bufotalin
3β : 5β : 14β : 19-Tetrahydroxy	Strophanthidol	Hellebrigenol
3β : 5β : 14β-Trihydroxy-19-aldo	Strophanthidin	Hellebrigenin

Derivatives of the genins in which the 14-*iso*-structure is preserved might be named similarly :

Table 2

Formula	Old name	New name
II	Dihydrogenin	14β-Hydroxydigitanolide (and -20-*iso*-digitanolide)
III	*allo*-Genin	14β-Hydroxy-17-*iso*-digitenolide
IV	*iso*-Genin	ψ-Digitenolide

Toad poisons. These compounds are derivatives of the 14-*iso*-choladienic acid lactone structure V, which might be called *bufadienolide*.

Thus bufalin (Meyer[3]) would be 3β : 14β-dihydroxybufadienolide. Table 1 gives the proposed systematic names of some cardiac aglycones and toad poisons. The proposed names are not awkwardly long, and they express the interrelationships of the compounds in a way that trivial names can never do.

The table makes obvious the fact that the toad poisons recently studied by Meyer[3,4]—see also Schmutz[5]—agree in the position and configuration of their substituents with the cardiac aglycones (for references to the latter, see Fieser and Fieser[1]).

Steroid sapogenins. These compounds are now formulated, following Marker and Rohrmann[6], as spiroketals. Their names might be based on the name *steroketal* VI. The following names are suggested :

Table 3

Formula	Old name	New name
VI	Sapogenin	Steroketal
VII	*iso*-Sapogenin (or a different trivial name)	22-*iso*-Steroketal
VIII	ψ-Sapogenin	ψ-Steroketal
IX	Dihydrosapogenin	Dihydro-ψ-steroketal
Examples :		
	Sarasapogenin	3β-Hydroxysteroketal
	Tigogenin	3β-Hydroxy-5-*allo*-22-*iso*-steroketal
	Neotigogenin	3β-Hydroxy-5-*allo*-steroketal
	Diosgenin	3β-Hydroxy-Δ^5-22-*iso*-steroketal

Compounds in which both oxide rings have been opened can best be named as derivatives of coprostane or cholestane, for example, tetrahydrosarsasapogenin = coprostane-3β : 16β : 26-triol.

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---

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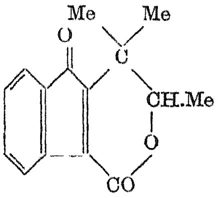
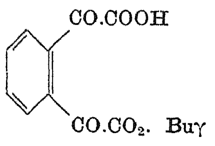
Indenone-Carboxylic Acids and *allo*-Dunnione

IT was shown by Price and Robinson[1] that the naphthoquinone pigment, dunnione, undergoes a remarkable rearrangement when heated with aqueous alkali. The product was evidently not a naphthoquinone, and the structure (I) was tentatively assigned to it.



I

Confirmation of the structure of dunnione, and further examples of the rearrangement[2], suggested that the rapid reaction with alkali is related to the presence of a tertiary group on the quinone ring. We have found that 2-hydroxy-3-*tert.*-butyl-1 : 4-naphthoquinone is also readily rearranged to a yellow crystalline acid, isomeric with the quinone. This observation was made independently by Dr. Ettlinger of Harvard[3], who also discovered that a colourless intermediate compound was formed when disodium hydrogen phosphate was used instead of sodium hydroxide. Ettlinger suggested that this compound might have the structure (II):



II

Very similar results have since been reported by Shemyakin and co-workers[4] in a study of the action of weakly alkaline buffers on phthiocol. Two acidic products were obtained, and some evidence was given that these compounds were *o*-propionyl phenylglyoxylic acid and 2-methyl-indenone-3-carboxylic acid.

Fieser[5] reported the rearrangement of 2-hydroxy-3-*cyclo*-hexyl-1 : 4-naphthoquinone, and we have found that 2-hydroxy-3-*iso*-propyl-1 : 4-naphthoquinone also gives an isomeric yellow acid when heated with alkali. The reaction can therefore occur with hydroxy naphthoquinones having primary, secondary or tertiary alkyl groups; but the rate appears to be greatest with the tertiary alkyl compounds.

There has been little direct evidence that the yellow crystalline isomers obtained in these reactions are, in fact, indenone-carboxylic acid derivatives, but we now report the synthesis of 2-*iso*-propyl-indenone-3-carboxylic acid, which we have found to be identical with the product obtained by rearrangement of 2-hydroxy-3-*iso*-propyl-1 : 4-naphthoquinone.

Phenyl-*iso*-propyl-succinic acid[6] was cyclized with sulphuric acid to give 2-*iso*-propyl-indenone-3-carboxylic acid (m.p. 103–104°). The ethyl ester of this acid was brominated, and the resulting bromo-derivative was heated with diethylaniline. Alkaline hydrolysis of the resulting ester gave 2-*iso*-propyl-indenone-3-carboxylic acid; yellow needles from light petroleum, melting point 146–147° alone or mixed with the product obtained by rearrangement of 2-hydroxy-3-*iso*-propyl-1 : 4-naphthoquinone.

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Sept. 28.

---

[1] Price and Robinson, *J. Chem. Soc.*, 1522 (1939).

[2] Cooke, *Nature*, **162**, 178 (1948).

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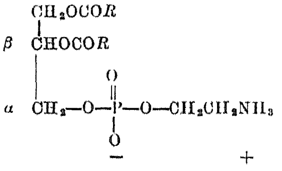
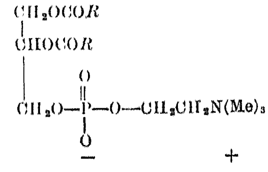
Structure of Kephalin: Presence of Serine and a Disaccharide in Groundnut Kephalin

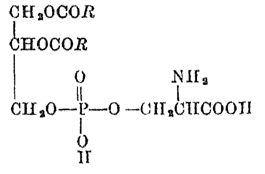
RECENT work on kephalin by Folch and co-workers[1–4] has made it clear that the classical view of its simple relationship to lecithin indicated by (I) and (II) requires very considerable modification.



(I) α-Kephalin



(II) α-Lecithin



(III) α-Phosphatidyl serine

R.CO represents a fatty acyl group, and the compounds may have either α- or β-glyceride structure.

Formula (I) has never, in fact, been entirely free from objection, since published analytical data are far too low in carbon, nitrogen and phosphorus. Moreover, it is not easy to explain on the basis of structures (I) and (II) the extreme insolubility in alcohol of kephalin, compared with lecithin, which forms the basis of their separation.

The problem has now been greatly clarified by the work of Folch, who has shown that the chief nitrogenous constituent of ox-brain kephalin is serine, although ethanolamine is present to a lesser extent. Further, he finds that compound (I) is freely soluble in alcohol, and is not, therefore, the substance usually referred to as kephalin, which is insoluble. Finally, he finds that ox-brain kephalin contains an alcohol-insoluble phosphatide which yields inositol, serine and glycerophosphoric acid on hydrolysis. These results go far to explain both the discordant analyses and the solubility anomaly.

It is clear from Folch's work that lecithin and kephalin, as commonly understood, are mixtures. Thus, lecithin, the fraction of greatest solubility in alcohol, is likely to consist of both (I) and (II) and possibly even (III) if the carboxyl group is free (as distinct from the sodium or potassium salt; many workers find potassium and sodium in kephalin, and we confirm this). For this reason Folch has proposed the terms phosphatidyl ethanolamine, phosphatidyl choline and phosphatidyl serine for (I), (II) and (III) respectively, and suggests that the names 'lecithin' and 'kephalin' be employed only for crude mixtures.

Although Folch's work has been confined to animal kephalin, there are sufficient analogies to anticipate parallel results with vegetable kephalin, and, indeed, both combined sugars and inositol have been reported in vegetable phosphatides[6-8].

We have now found, in addition to inositol, a combined disaccharide and serine in kephalin from groundnut oil. This material is an alcohol-insoluble powder which comprises some 60 per cent of the total phosphatides of groundnut lecithin. It gives a positive Molisch test, but does not reduce Fehling's solution until after hydrolysis with mineral acid. Analysis gives: C, 57·9; H, 9·1; N, 1·2; P, 2·9; amino-N (van Slyke), 0·58 per cent; acetyl value, calculated as OH, 9·0 per cent; calculated values for (I) (di-oleyl), for comparison, are C, 66·0; H, 10·7; N, 1·88; P, 4·16 per cent.

Hydrolysis of this powder for twelve hours with boiling $N/100$ sulphuric acid and evaporation of the neutralized (baryta) and filtered hydrolysate yielded a syrup, which was found by paper chromatography (*n*-butanol) to contain a disaccharide and a small amount of arabinose; and, after further hydrolysis of the syrup with $2N$ sulphuric acid, galactose and an increased amount of arabinose, were identified by the same method. Pending the isolation and characterization of the disaccharide, we assume that the presence of arabinose in the first hydrolysate indicates that it is a galacto-arabinoside.

The basic constituents have been investigated by the chromatographic method used by Chargaff *et al.*[9] in their study of tissue phosphatides, and we find both ethanolamine and serine present, this being, so far as we are aware, the first time that the latter has been reported in a vegetable phosphatide. We also noted on our chromatogram, as did Chargaff, the presence of a slower-moving substance, which responded to the ninhydrin test. This we have identified chromatographically as the phosphate ester of ethanolamine. Choline was not present on our chromatogram.

Inositol was detected both chromatographically and by the Scherer test, after hydrolysis of our starting material with $2N$ sulphuric acid in a sealed tube at 100° for twelve hours. In a private communication to one of us (H. H. H.), Dr. D. W. Woolley stated that a sample of groundnut phosphatides supplied by Messrs. J. Bibby and Sons, Ltd., contained some 5 per cent of inositol.

Our results thus indicate that groundnut kephalin is mainly a mixture of phosphatidyl-ethanolamine and -serine, each combined with a galacto-arabinoside or inositol or possibly to some extent with both, since both the phosphate hydroxyl and the free amino-group are possible points of attachment. The most noticeable difference in the analytical data of the inositol compounds of Folch and Woolley and that of our kephalin is that the whole of their nitrogen is present as free amine, whereas only half of ours is free. This suggests that the sugar may be attached to the amino-group, whereas the inositol, as would be expected, is attached to the phosphate group.

We are grateful to Dr. J. K. N. Jones for advice on sugar chromatography, to Mr. C. L. Bibby for his interest and helpful criticism, and to Messrs. J. Bibby and Sons, Ltd., for a grant which greatly assisted this work.

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β-Aroylpropionic Acids

WHEN a solution of phenol and succinic anhydride in acetylene tetrachloride was cooled in a freezing mixture and treated slowly with aluminium chloride, at such a rate that the temperature of the reactants did not exceed 0°, and the reaction completed as stated by Mitter and Shyamakanta[1], then the product was found to be a mixture of β-(*o*-hydroxybenzoyl)propionic acid (m.p. 145°) and β-(*p*-hydroxybenzoyl)propionic acid (m.p. 160°), in which the *o*-hydroxy-acid was predominant. This is contrary to the statement of Mitter and Shyamakanta[1], that the only product of the reaction is the *o*-hydroxy-acid.

The separation of the two acids was carried out either by (i) fractional crystallization from water, when the *o*-hydroxy-acid, being less soluble, crystallizes out first, leaving the *p*-hydroxy-acid in solution, or (ii) by making use of the fact that the *o*-hydroxy-acid is not easily etherified with dimethyl sulphate; the mixture of acids was, therefore, treated with dimethyl sulphate in boiling 20 per cent sodium hydroxide solution, and the precipitated acids were esterified with hydrogen chloride gas and methyl alcohol. The esters formed were extracted with alkali; the insoluble fraction gave on hydrolysis β-(*p*-methoxybenzoyl)propionic acid (m.p. 151°), undepressed on admixture with an authentic specimen)[1]. The phenolic fraction was hydrolysed to β-(*o*-hydroxybenzoyl)propionic acid. This acid, however, was easily methylated, by refluxing its acetone solution with methyl iodide in presence of dry potassium carbonate[2], to methyl β-(*o*-methoxybenzoyl)propionate, which was hydrolysed to β-(*o*-methoxybenzoyl)propionic acid (m.p. 100°).

Reduction of β-(*o*-hydroxybenzoyl)propionic acid with amalgamated zinc and hydrochloric acid gave γ-(*o*-hydroxyphenyl)butyric acid (m.p. 67°)[1], which was methylated with methyl iodide and potassium carbonate in acetone solution to methyl γ-(*o*-methoxyphenyl)butyrate (b.p. 122–124°/3 mm.). When this was hydrolysed with 10 per cent alcoholic potassium hydroxide and the product distilled in vacuum (b.p. 165–168°/2 mm.), it gave γ-(*o*-methoxyphenyl)butyric acid (m.p. 41–42°)[3]. The latter acid could also be prepared by the reduction of β-(*o*-methoxybenzoyl)propionic acid with Clemmensen's modified method[4].

Attempts to prepare β-(*o*-methoxybenzoyl)propionic acid by the action of *o*-anisylmagnesium bromide on a boiling benzene solution of succinic anhydride gave a product of melting point 178°, which was found to be identical with the product obtained by the action of *o*-anisylmagnesium bromide on a boiling benzene solution of β-(*o*-methoxybenzoyl)propionic acid. It was insoluble in cold potassium hydroxide solution, and dissolved only on refluxing for a long time. On acidifying the ice-cold alkaline solution, an acid was precipitated which was freely soluble in potassium carbonate solution. However, this acid was partially converted into the original product on boiling with dilute hydrochloric acid. This property, besides the results of analyses, showed that the product is a lactone, most probably that of γ : γ-di-(*o*-anisyl)-γ-hydroxybutyric acid. Its exact constitution as well as the mechanism of its formation are now under investigation.

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Products of the Hydrolysis of Wool Keratin by Papain

THE study of the action of enzymes on proteins is engaging the attention of a number of workers. The present communication describes the results of an investigation into the products formed when papain acts on wool keratin. This reaction has been described previously[1]; but little is known about the hydrolysis products.

In order to investigate the peptides formed in the reaction, a 56's quality virgin wool was treated with 2 per cent papain (calculated on the weight of the wool) for 3½ hr. at 65° C. in 1 per cent sodium bisulphite solution. These conditions, which are much more drastic than those used in commercial treatment to impart felting resistance, break up the wool fibres into cortical cells which are readily removed by centrifuging. When the supernatant solution containing the peptides formed in the reaction is acidified to *p*H 4 a gelatinous precipitate, which forms a hard horn-like mass on drying, separates out. This polypeptide contains a wide variety of amino-acids, but its cystine content is much lower than that of the cortical cells formed simultaneously. The X-ray diffraction diagram, for which I am indebted to Dr. T. C. Tranter, showed that this peptide had a disordered β-keratin type of structure. It would seem to be of fairly long chain-length; but whether it forms an intermediate in the reaction is not yet known.

Those peptides which remain in solution after acidification constitute the greater part of the material going into solution during the papain digestion, and have a mean chain-length of five amino-acid residues. They were examined by chromatography on paper. A two-dimensional chromatogram in collidine and phenol-ammonia showed the presence of a strong glycine 'spot' but no appreciable amount of other free amino-acids. This liberation of glycine may indicate that it is split off from some special position in the wool keratin molecule, and, in fact, glycine has been found to terminate some of the peptide chains of wool[2,3]. An alternative explanation is that peptide bonds on both sides of glycine residues in the middle of the chain are split much more rapidly than other peptide bonds, glycine having no side chain in such a spacial arrangement that it can hinder the approach of the enzyme[4].

A greater degree of separation of the low molecular-weight peptides was achieved by running one-dimensional chromatograms in other solvents such as *n*-butanol. Several 'spots' were observed which tended to 'tail' into each other. The amino-acids present in the various peptide 'spots' were investigated by elution from the paper and hydrolysis. Although the investigation is not yet complete, differences in amino-acid composition between the various peptides have been observed. It is probable that each 'spot' contained a mixture of peptides, and that there are a large number of peptides of differing degrees of complexity present in the papain hydrolysate of wool, of which only a partial separation has so far been achieved.

The complex nature of the mixture of peptides is also indicated by end-group determinations by Sanger's method[5], using buffered columns to separate the $2:4$ dinitrophenylamino-acids[6]. The following terminal amino-acids, that is, those carrying free amino-groups, were found among these peptides: leucine + *iso*leucine, valine, alanine, glycine, threonine, serine, glutamic acid and aspartic acid. No appreciable quantities of free amino-groups belonging to the basic amino-acids arginine, lysine and histidine were detected, however. The enzyme thus liberates a large number of different amino-groups from the peptide linkages, and in this respect does not exhibit a very high degree of specificity in its action on wool. Bergmann and co-workers[4,7] considered that papain was able to hydrolyse the most varied types of peptide bonds, though at widely different velocities. These conclusions, obtained in studies on relatively few synthetic peptides, may not necessarily be applicable to proteins.

I am indebted to the Council of the Wool Industries Research Association for permission to publish this note, and to G. R. Lee for assistance with the experimental work.

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Low-Temperature Decomposition of Rocks, Ores and Minerals by Sodium Peroxide using Platinum Vessels

RECENT work at the Dominion Laboratory on the decomposition and analysis of refractory minerals has led to the belief that the lower the temperature of decomposition using the common fluxes the more soluble are the products in water or acids. The time for complete decomposition at the correct temperature for the flux appeared to be only a few minutes or even less.

The effectiveness of sodium peroxide as a decomposing agent is well known; but its usefulness has been limited by its corrosive action on the vessel used during prolonged heating at high temperatures. Experiments have shown, however, that such prolonged heating and high temperatures are unnecessary with this reagent, and that many refractory minerals can be effectively decomposed by heating with sodium peroxide for a few minutes only at a temperature below 500° C. In these experiments a platinum crucible was used, and after repeated decompositions no attack on the platinum could be detected.

The finely powdered mineral, ground to pass a 240 B.S.S. sieve, was mixed with sodium peroxide in the ratio of 1 : 4 in a platinum crucible and covered with a light layer of peroxide. The crucible was placed for seven minutes in a muffle furnace held at a temperature of 480° ± 20° C. On removal, the crucible was cooled quickly and the readily detachable sintered cake dropped into 50–100 ml. of cold water. Rapid and complete disintegration took place either in the alkaline solution so formed or on acidifying by the rapid addition of acid to the cold suspension.

The method outlined appears to be applicable to a wide variety of inorganic compounds and should be particularly useful in treating some minerals hitherto regarded as difficult to decompose. So far it has been used successfully to decompose the following: chrome refractory, bauxite, flint clay, zircon, chromite, wolfram, scheelite, rutile, magnetite, garnet, cassiterotantalite, titanite, beryl, black ilmenitic sand, glass sand, greensand, gypsum, celestine, baryta, feldspar, basalt, rhyolite, trachyte, andesite and osmiridium. The last-named required four successive treatments before complete solution was attained. Caution is indicated in heating sulphides with sodium peroxide, as the heat of reaction may result in temperatures high enough to cause attack on the vessel used.

The mechanism of the reaction with sodium peroxide and its application to the assay of ores, inorganic analysis, the preparation of salts and the possible recovery of metals from their ores are being investigated further.

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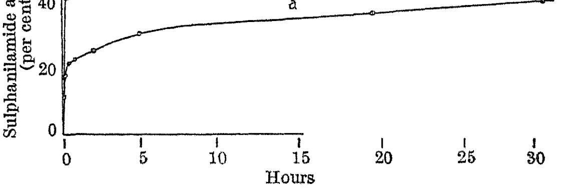
Acetylation of Sulphanilamide by Acetyl Metaphosphate

THE problem regarding the nature of the reactive intermediate C_2-compound in acetate metabolism is not clear at present. With regard to biological acetylations, it is evident, especially from Lipmann's[1] work, that a strongly acetylating substance is formed in an enzymatic reaction between acetate and adenosine triphosphate. According to Lipmann's recent papers[2], this intermediate is different from acetyl phosphate, but is transformed to acetyl phosphate in acid solution at room temperature. We have considered the possibility that the primary product in the phosphate transfer from adenosine triphosphate to an acceptor might be a metaphosphate compound. Some chemical and biological points in favour of this hypothesis will be discussed elsewhere.

Lipmann[3] has shown that, in the enzymatic acetylation of sulphanilamide, acetyl phosphate is not able to replace adenosine triphosphate + acetate as acetylating agent. According to the above hypothesis, acetyl metaphosphate would be the primary product in the reaction between adenosine triphosphate and acetate. We have therefore studied the analogous non-enzymatic reaction with acetyl metaphosphate as acetyl donor, and observed a rapid acetylation of sulphanilamide.

Acetyl metaphosphate was synthetized by adding excess of silver metaphosphate to a solution of acetyl chloride (usually 1–5 gm.) in 25 ml. dioxane at 0° C. After shaking the mixture for about three days, no chlorine is found in the solution. After centrifugation, the solution is yellow to brown or black, depending on the amount of acetyl chloride used. Attempts to isolate acetyl metaphosphate by precipitation or by evaporation of the solvent resulted in the formation of dark products. Therefore the solution was used as such. Analysis of the solution gave values slightly higher for acetyl than for phosphorus.

1 ml. of the dioxane solution was mixed with 20 ml. of an aqueous solution of sulphanilamide in $M/15$ phosphate buffer, pH 7·5, at room temperature. The degree of acetylation was determined by coupling the non-acetylated diazotized sulphanilamide with N-ethyl α-naphthylamine (kindly supplied by H. Lundbeck and Co., Copenhagen) and photometric analysis according to Frisk[4].



Curve *a*: $2 \cdot 8 \times 10^{-2}$ *M* sulphanilamide; curve *b*: $2 \cdot 8 \times 10^{-3}$ *M* sulphanilamide

The results of two experiments are seen in the accompanying graph. In both experiments, the concentration of acetyl metaphosphate (according to analysis for phosphorus) in the reaction mixture was 4×10^{-2} molar. The two curves correspond to different sulphanilamide concentrations. The rate of acetylation is seen to be rapid in the first 15 min. or so after mixing, after which there is a period of much slower acetylation. We consider the first period as representing acetylation by acetyl metaphosphate. The later period may represent acetylation by acetyl pyrophosphate, or by diacetyl pyrophosphate formed in the solution by a reaction between acetyl metaphosphate and water.

These results are compatible with the hypothesis of acetyl metaphosphate being the natural intermediate in the reaction between adenosine triphosphate and acetate. A better proof of this hypothesis can be obtained by investigations with the acetylating enzyme system and acetyl metaphosphate. Experiments of this kind are in progress.

We are indebted to Prof. K. Linderstrøm-Lang for his interest in this work.

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Mucilage of *Dumontia incrassata*

THE red alga *Dilsea edulis* (natural order, Cryptonemiales; family, Dumontiaceæ) has recently been shown to yield a mucilage which consists of a galactan sulphuric ester containing two SO_3H groups and one uronic acid lactone residue associated with nine galactose residues. The linkages of the galactose residues are predominantly 1 : 3; but about one in every five is linked 1 : 4 [1,2].

We have now examined the mucilage of *Dumontia incrassata*, a more commonly occurring member of the family Dumontiaceæ[3]. This mucilage had already been extracted by Kylin[4] and shown by him to contain galactose.

According to Kylin, the mucilage of *D. incrassata* is extracted in large quantities on standing in water for several days at room temperature. We have found that the plant rots easily when an attempt is made to dry it in the air, or when it is left in water, and that the most satisfactory method of extraction is to immerse the freshly gathered plants in 2 per cent hydrochloric acid for about a week. After filtration of the viscid solution through linen bags, alcohol precipitates the polysaccharide as a white mass somewhat less stringy than the mucilage of *D. edulis*. Like the latter, it dries to a fibrous mass which gives a highly viscid solution in water, but does not form a gel. The yield of crude mucilage is about 1 per cent of the weight of the fresh plant. By dialysis against $N/2$ hydrochloric acid, followed by distilled water, the ash content was reduced to 2·5 per cent.

The product thus purified has a specific rotatory power (corrected for ash and moisture) of + 53 (cf. + 47·2 for the *Dilsea* mucilage[1]). A 1 per cent solution has a pH of about 2. Aqueous solutions give, with ferric chloride, a reddish-brown precipitate, which, unlike the corresponding precipitate of the *Dilsea* mucilage[1], is insoluble in dilute acetic acid, though soluble in mineral acids.

The mucilage contains no sugar other than galactose, and it contains esterified sulphuric acid and a uronic acid residue, which, like that of the *Dilsea* mucilage, appears to be in the form of a lactone.

By oxidation with periodic acid and estimation of the glyoxal in the oxidized product as osazone[1], it was established that about five galactose units were unattacked, and therefore linked 1 : 3, for every unit oxidized. The linkages of these oxidized units have not so far been determined by methylation experiments; but it is most probable that they would prove to be 1 : 4, as in the *Dilsea* mucilage.

So far, the mucilage appears to be identical with that from *D. edulis*. Determinations of uronic acid and of esterified sulphuric acid, however, showed that the mucilage of *D. incrassata* contains *four* SO_3H groups and one uronic acid residue associated with nine galactose residues, giving the formula $[(C_6H_{10}O_5)_9(C_6H_6O_5)(SO_3)_4]_n$.

Algal galactan sulphuric esters are now known in which the ratio sulphate radical to galactose radical (plus uronic acid when present) is 1 : 1 (*Chondrus crispus*[5] and *Irideæ laminarioides*[6]), 2 : 5 (*D. incrassata*), 1 : 5 (*D. edulis*), 1 : 42 (*Gelidium crinale*[7]), 1 : 45 (*Gracilaria confervoides*[7]) and 1 : 55 (*Gelidium latifolium*[8]).

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Oxidation of Ascorbic Acid by Plant Extracts

THAT the catalytic agency responsible for vitamin C oxidation in plant extracts is a specific copper-protein enzyme has been shown by several workers[1]. There is, however, disagreement as to whether the oxidase activity is exerted by this complex, or by the ionized copper from it. Active preparations of artificial oxidases, with ionic copper as the responsible constituent, have been reported[2]. On the other hand, purified preparations of the enzyme have been found to oxidize ascorbic acid many times faster than an equivalent quantity of cupric ion[3].

The following observations, made in the course of investigations on the biogenesis of vitamin C in plants, provide a further distinction between the oxidations caused by the oxidase and by the cupric ion:

(1) There was no oxidase activity in extracts of seeds soaked overnight of legumes such as mung (*Phaseolus radiatus*), masoor (*Lens esculenta*), black pea (*Pisum arvense*) and matki (*Phaseolus aconitifolius*). Only a slight activity was noticeable on the second day of germination following this preliminary period of soaking. Activity increased with the subsequent progress of germination.

(2) Extracts of seeds soaked overnight, when added to an ascorbic acid oxidase preparation from cucumber rind, caused a nearly two-fold enhancement in its capacity to oxidize the vitamin. This characteristic of seed extracts was thermostable and diminished rapidly with germination, being absent on or after the fourth day.

(3) In contrast, the extract protected ascorbic acid against oxidation by cupric ion; this was shown even during progressive germination. Thus, in one instance, extract from seeds soaked overnight inhibited completely the oxidative action of a 0·01 per cent solution of copper sulphate; corresponding inhibitions exerted on the fourth and sixth days of germination were 35·1 and 29·5 per cent respectively. This effect was caused by both heated and unheated (that is, in presence of oxidase) extracts. Similar inhibition of the action of cupric ions on ascorbic acid by heated plant extracts has been reported earlier[4].

(4) The degree of inhibition reported in (3) was the same when the copper solution was heated with the extract and then allowed to oxidize ascorbic acid, as when it oxidized the vitamin in presence of previously heated extract.

(5) Oxidase activity of extracts from seedlings which had been germinated for four to five days, freed from cupric ions by dialysis but not purified, was about five times greater than that caused by the copper present in it.

Fuller details, together with a postulated mechanism whereby ionic copper, in presence of a specific agency, constitutes the ascorbic acid oxidase of plant extracts, and which would explain the foregoing and related observations, will be published elsewhere.

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An Unstable Lattice in Silk Fibroin

THE filament of the silkworm *Bombyx mori* gives the well-known X-ray fibre diagram[1], which can also be obtained by stretching the silk-gland taken from the animal[2].

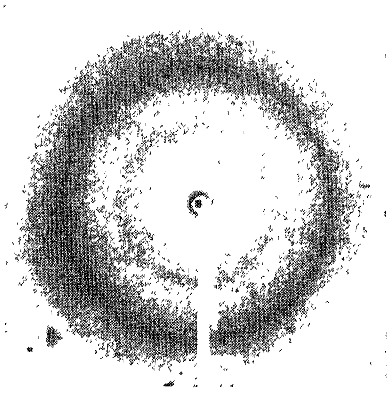
Table 1

D	Intensity
7·5	moderate
4·9	weak
4·5	strong plus
4·0	very weak
3·6	strong
3·1	strong
2·6	weak
2·4	rather weak

Table 2

Silk I	*F*-Actin
7·5	7·9 6·8 strong
4·5	4·5 strong
	4·2 moderate
3·60	3·60 moderate
3·10	(3·10 very weak)

R. Brill[3] discovered that the fibroin in the living silkworm gives only completely amorphous diagrams which are, however, converted into Debye–Scherrer diagrams if the gland is air-dried. No further details about these diagrams were given. Aiming at a more detailed study of the crystallization process, we have repeated his experiments. It is remarkable that the X-ray photographs obtained by drying the native fibroin present an exceedingly discrete powder diagram (see photograph and Table 1) which does not agree quantitatively with the well-known diagram, neither with regard to the net-plane distances *D*, nor where the intensities are concerned. The net-plane distances are very similar to the smaller ones of actin[4], as shown by Table 2. Hence, the fibroin, which is present in the native silk gland in a dispersed state, forms crystals on drying. The extremely sharp reflexions suggest that the crystals form without interference and are much bigger than those of the spun silk fibroin.

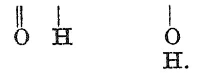


One is tempted to interpret these results in accordance with Astbury[5], who assumes that fibre proteins form by aggregation of 'monomer' particles, and that a following deformation may disturb the original high regularity, causing the polypeptide chains to unfold.

It has been found that a transition to the well-known β-diagram occurs very easily, and it is due to this fact that it has unfortunately been impossible, so far, to achieve an orientation of the primarily formed crystallites in order to measure the fibre period.

We suggest denoting the newly found lattice type as 'silk fibroin from *Bombyx mori*, type 1', as contrasted to the well-known 'type 2'. We may also mention that 'silk 1', after swelling in concentrated formic acid, gives a typical amorphous diagram with two intense, broad interference rings. These correspond approximately to the net-plane distances 7 A. (medium) and 3·5 A. (strong). A final explanation of this diagram is, of course, not yet possible; however, it appears reasonable to consider these distances as the first and second order of a distance characteristic for the single amino-acid (side-chain distance).

On drying the sample, the unchanged 'diagram 1' is again obtained. After any stretching of preparations of type 1—which is, of course, only possible after swelling, for example, in formic acid—the well-known 'diagram 2' is obtained, even if the extension keeps within the elastic region (15 per cent stretching).

At the first orientation, the flat micelles of 'lattice 2' turn—as known—parallel to the plane of the film. An X-ray photograph perpendicular to the plane of the micelles shows the remarkable effect of a faint double structure, namely, with the chain directions parallel and perpendicular to the direction of stretching. Considering the mechanism of the stretching of a micellar network, such an effect at lower degrees of stretching seems understandable. Higher degrees of stretching easily lead to the well-known higher orientation, with good alignment of both axes of the micellar planes. On swelling preparations of 'lattice 2' in formic acid, the crystal reflexions disappear, as already established by Meyer and Mark[6]. On drying, 'lattice 2' reappears. Once the 'lattice 2' had been reached, it has, so far, been absolutely impossible to reproduce the original 'diagram 1'. When the native silk fibroin is dissolved in 10 per cent sodium hydroxide and precipitated with ammonium sulphate, one obtains a diagram showing only one strong reflexion which, within the range of experimental error, is equivalent to the net-plane distance A_3 of 'lattice 2', corresponding to 4·3 A. This value, which corresponds to the backbone distance, has obviously not been affected. One is tempted to assume greatly damaged lamellæ with hydrogen bonds in the direction of the backbone. A fundamental difference between lattices '1' and '2' is also that 'type 1' never shows an additional absorption band at 4,000 mm.$^{-1}$, which appears only in type '2'[7]. The band has been ascribed to the formation of C=N groups within the peptide chains, by transition of  $-\underset{\underset{\textstyle O}{\|}}{C}-\underset{\underset{\textstyle H}{|}}{N}-$ to $-\underset{\underset{\textstyle OH}{|}}{C}=N-$.

The experiments are being continued. We are much indebted to J. O. Fixl for valuable assistance and careful measurements.

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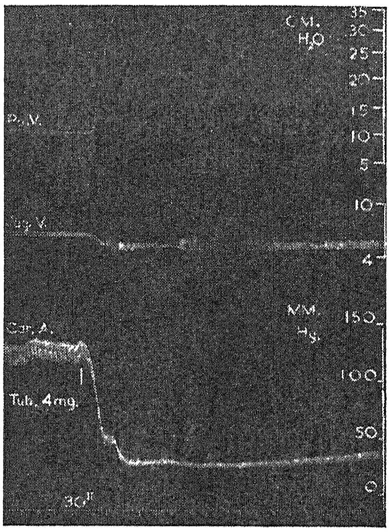
Liberation of Heparin and Histamine by *d*-Tubocurarine

IT is well known that curare[1] and tubocurarine[2] liberate histamine from skeletal muscle. I have perfused the isolated lungs of the guinea pig as described by Feldberg and Kellaway[3], and find that tubocurarine chloride (B. W. and Co.) in doses of 1–10 mgm. liberates histamine, the output of which resembles in magnitude and time that caused by injury by peptone or anaphylaxis.

When tubocurarine (0·25–15 mgm.) is injected into the portal vein of the dog under chloralose, in about 20 sec. there is a sharp rise of portal pressure with a fall in systemic arterial and venous pressures (see trace). Systemic intravenous injection causes a fall of arterial and venous pressures ; the portal pressure also falls, interrupted by a small transient rise only. This indicates that the rise of portal pressure is mainly due to an action of the drug within the liver itself. That this action is one of histamine liberation is shown by the antagonism of benadryl to small doses of tubocurarine given intra-portally and by the detectable loss of liver histamine with larger doses. The smallest dose (0·25 mgm.) caused a rise of portal pressure greater than that caused by the intraportal injection of 50 μgm. of histamine-acid phosphate, and with large doses, although no direct match was possible, the effect was probably equivalent to that of several milligrams of histamine. The loss of histamine, estimated by comparing the content of two pieces of liver removed before and after injection, varied from no detectable loss to a loss of 44 per cent. Thus in one experiment, in which 3 mgm. of tubocurarine was injected intra-portally, the histamine content fell from 55 to 36 μgm. per gm., representing a total loss of some 5·7 mgm.



On the other hand, when the isolated liver is perfused with Tyrode or heparinized blood containing tubocurarine, no more than a few micrograms of histamine appear in the perfusate, and no loss from the liver is detectable. This resembles peptone and anaphylactic injury in that large quantities of histamine are released *in vivo* but not from the perfused liver[4]. This similarity suggested the possibility that heparin was liberated as with peptone and anaphylaxis, and this was clearly shown to be so. Following the intraportal injection of 4–15 mgm., arterial blood withdrawn within 20 min. after injection had not coagulated 24 hr. later in three experiments, and in a fourth experiment the clotting-time had increased from 5 to 60 min. The blood could be promptly clotted by thrombin or protamine. A typical titration[5] showed that blood, taken 4, 10 and 22 min. after the injection of 10 mgm. of tubocurarine, required the addition of 0·02, 0·015 and 0·02 mgm./0·5 c.c. blood of protamine respectively to reduce the clotting-time to its lowest value.

Recently it has been shown[6] that certain organic bases the depressor effects of which resemble those of a very large group of compounds, including tubocurarine, liberate histamine and heparin, and it is considered that the liver is the main site of action in the dog. My results show that tubocurarine liberates heparin, and direct attention to similarities between its action and peptone and anaphylactic injury. However, in the dog, the results of systemic intravenous injection of the drug indicate that the liver is not the main site of histamine liberation in these circumstances.

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Quantitative Determination of Dehydro*iso*androsterone in Pure Solutions and in Urine Extracts

2 ml. of pure concentrated sulphuric acid are added drop by drop to 0·1 ml. of a solution of dehydro*iso*androsterone in ethyl alcohol or of an extract containing 5–50 γ of that substance in a test tube. The mixture is heated to 60° C. for 25 min. and then cooled in ice water. The chilling is discontinued, and 5 ml. ethyl ether (water- and peroxide-free) are added slowly while the mixture is thoroughly stirred with a glass rod.

As a result of the above procedure, dehydro*iso*androsterone gives a blue colour which, when measured in a Pulfrich photometer, has maximal absorption at 570 mμ. With an extract or an eluate, the maximal colour intensity is first obtained after an additional 2 min. heating to 100° C. The extinction values at 570 mμ for pure solutions are proportional to the concentration of dehydro*iso*androsterone up to 60–70 γ. In cases where 0·1 ml. of extract (20 ml. extract corresponds to the amount of urine excreted in 24 hr.) gives, by the method described above, a blue-violet reaction colour ($E\,530/E\,570 < 0{\cdot}95$), one can say with certainty that the patient in question is suffering from some hormonal disorder which is evidenced by an increased excretion of 3β-hydroxy-17-ketosteroids.

In order to obtain a more exact determination of the amount of dehydro*iso*androsterone in urine extracts, it is necessary to carry out first a chromatographic fractionation of, for example, 2 ml. of the extract, and to work out a curve for the correction of the extinction values obtained. Such a curve has been drawn by determining known quantities of dehydro*iso*androsterone which have been added to different extracts and eluates in varying amounts (3–50 γ). Of the different quantities used (unknown to the analyst) 85–110 per cent has been found.

Determinations on many urine extracts have given values from 147 mgm. per 24 hr. (virilizing ovarian tumour with metastases) to 0·2 mgm. (normal cases) of dehydro*iso*androsterone. In a four-year-old girl with pubertas præcox, we found 7·4 mgm. dehydro*iso*androsterone, which corresponded to 55·7 per cent of the total excretion of 17-ketosteroids. In several cases of hirsutism with hypertension and in some cases of Cushing's syndrome, we have demonstrated amounts of dehydro*iso*androsterone corresponding to 14–30 per cent of the total neutral 17-ketosteroid excretion. In two cases of adrenocortical adenoma (♀), we have found a total of approximately 20 mgm. neutral 17-ketosteroids; 22–28 per cent thereof gave the dehydro*iso*androsterone reaction. In one case of adrenocortical carcinoma (♀), 41 mgm. of 17-ketosteroids were found and 54·4 per cent was determined as dehydro*iso*androsterone.

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Rotational Slip—a New Deformation Process in Crystals

During the past three years I have collected evidence (now being published, submitted July 1949) that a new kind of slip is common in crystals. It is proposed to call it 'rotational slip', and it can be defined as the slipping of one part of a crystal on a neighbouring part, so that the two atomic sheets which slide over one another are densely populated planes, as in translational slip, but rotationally displaced about an axis normal to their plane (with or without simultaneous translational displacement) to one of a series of definable new positions where metastable equilibrium can occur. There is then only a two-dimensionally periodic partial fitting together of the two crystal parts. Neither the occurrence nor the nature of such slip has been clearly demonstrated hitherto.

It is now shown that for rectangular plane lattices (including centred-rectangular, that is, rhombus and hexagonal) an azimuthal displacement δ corresponds to a high order of density of coincident points in the contact plane, if $\tan \delta/2 = v_1 b/u_1 a$, or $u_2 a/v_2 b$, where u_1 and v_1 or u_2 and v_2 are relatively small integers. In the first case, the $[u_1 v_1]$ and $[u_1 \bar{v}_1]$ lattice rows then coincide along the direction bisecting the two a-directions, and in the second case $[u_2 v_2]$ and $[\bar{u}_2 v_2]$ coincide along the bisector of the two b directions. If both conditions are fulfilled simultaneously, $u_1 u_2/v_1 v_2 = b^2/a^2$. If also v_1 and u_2 are unity, the lattice of coincidence points is then similar to the plane lattice of either of the rotated sheets but enlarged in the ratio $\operatorname{cosec} \delta/2$ and rotated by 90° relative to the directions bisecting the a- and the b-directions; otherwise it has these axes further enlarged in the ratios v_1 and u_2 respectively. The main predicted angles δ were clearly recognized in a ball-bearing model simulating atomic packing, when one layer was rotated over another, and the 'moiré' pattern of two superposed perforated zinc sheets illustrated well the variation in size of the coincidence pattern with δ.

Exactly the same set of azimuths δ corresponds to the optimum fitting of two crystals (of the same species) which are rotationally displaced about an axis c normal to the common plane (a,b), though in contact not on this plane, superposed, but on a plane $(v_1 u_1 0)$ or $(v_1 \bar{u}_1 0)$ (or alternatively $(v_2 u_2 0)$ or $(v_2 \bar{u}_2 0)$), that is, laterally adjacent crystals. Simultaneous lateral and superposed contact of two such crystals can also therefore occur. Examples of this lateral fitting are well shown in 'polycrystal' bubble-raft photographs published by Dyson[1], with the corresponding optical diffraction patterns.

From electron-diffraction photographs from cadmium iodide, graphite, copper, silver, etc., many recorded about 1936, and from others obtained in this laboratory during 1933–49 [2], and also elsewhere[3], many cases are illustrated of spot patterns from a wide variety of crystals, showing close agreement with the above δ-values between successive members of triplet, quadruplet or higher groupings of crystals having a common direction of orientation (usually relative to the substrate collodion film or the specimen surface). The features of these diffraction-spot groupings (secondary-scattering effects indicating crystal superposition; equidistant spots of the group; 'tadpole-shaped' arcs), and in some cases their known origin from mechanical deformation, led to the conclusion that at least in many of the examples they were due to a coherent subdivision of crystals by rotational slip as defined above. The plane on which such slip occurred was often the plane of cleavage, to which process rotational slip is related in respect of the cohesionally strong binding of the atoms in the planes and the weaker binding between those of the adjacent superposed planes.

Macroscopic rotational slip on cleavage planes was easily shown in potassium ferrocyanide trihydrate and in gypsum, induced in a regular (microscopically) lamellar manner by couples applied tangentially by frictional grip over the whole area of the cleavage-plane surface, with the aid of a sufficient simultaneous vertical pressure which was greater in gypsum than in the ferrocyanide. Some twisted crystals (quartz, pyrites, etc.) illustrated in the literature appear to have undergone similar regular rotational slip on simple lattice planes.

It is concluded that still further examples of rotational slip, produced by directed forces applied on single crystals, occur in (1) development of 'deformation bands'[4], which are evidently initially simply the coherent subdivision of the crystal by rotational slip (note that in iron they form along {100}, which is its fracture plane, though also sometimes along {111}; and in aluminium along {100}—which is a rotational-slip plane indicated by the present results—and, as Barrett states[4], "possibly along others" also[5,6]); (2) the lattice deformation caused by unidirectional abrasion of a single-crystal surface along a direction parallel to a densely populated plane, such surface deformation often consisting of extensive rotational slip of lamellæ which are parallel to a cleavage plane or other simple plane (or, in ionic lattices, a plane or composite layer unit containing equal amounts of + and − charges), especially such planes normal to the surface. This second case is now deduced from electron-diffraction photographs from lead sulphide[7], sodium chloride[8] and magnesium oxide[9] abraded on {001} along <100>, hitherto not satisfactorily interpreted and, indeed, though apparently explicable in sodium chloride and magnesium oxide as due to flexural translational slip on {101} about the axis <010> normal to the abrasion direction, not so explicable in lead sulphide where translational slip has only been observed on {001}[5].

Finally, the observed coherence, at azimuthally preferred positions, between pre-existing crystals coming together on plane faces during their growth[10], is consistent with the existence of rotational slip as defined above, and these cases, as well as the azimuths of preferred fitting observed in rotational slip, demonstrate that epitaxial orientation of one crystal on another need not depend on having densely populated lattice rows parallel in the two crystals, or on a stepped form of crystal surface. It is suggested, further, that the stress caused when crystals grow epitaxially on a substrate crystal having different lattice dimensions is likely to give rise to rotational slip in some cases[5] and to mechanical twinning in others.

Many other properties of crystals are similarly clarified when considered in the light of the above results.

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New Absorption Lines in the Arc Spectrum of Aluminium

THE predicted terms, in L—S coupling, of an sp^2 configuration, are $^4P, ^2D, ^2P, ^2S$. In the case of Al I (ground-term $3s^2 3p\,^2P^0{}_{1/2}$), values for all four terms arising from $3s3p^2$ have been reported[1]. Of these four identifications, only one—that of ^4P by Paschen[2]—seems hitherto to have been regarded as reasonably certain. The ^2S term has been located at − 3474·0 cm.$^{-1}$, on the basis of a diffuse emission line-pair found at 1936·45 A., 1932·25 A. by Selwyn[3]; he interpreted the pair as $3^2P^0{}_{1/2\ 3/2} - 3s3p^2\,^2S_{1/2}$, since the separation was equal to that of the ^2P ground-term. The assignment seems to have been regarded as doubtful by Paschen[2], and though quoted in the recently published Bureau of Standards term tables[1], is there shown followed by a question mark.

Plates recently taken in this laboratory have substantiated Selwyn's finding. In the spectrum of an arc in nitrogen, between a carbon anode and an aluminium bead on a carbon cathode, the line-pair specified was obtained completely reversed on the continuum extending from the common limit of the S- and D-series of the simple spectrum, under conditions in which these series lines also showed heavy reversal. Afterwards, a direct absorption experiment, using aluminium vaporized in a carbon-tube furnace, with the hydrogen continuum as background, showed Selwyn's line pair in absorption. This, taken together with the fact that the separation of the lines is that of the ground-term components, is conclusive. Yet a further point is that the placing of the term agrees well with the application of the irregular doublet law to the sequence Al I to Cl V.

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Oct. 10.

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[1] For references see Moore, C. E., "Atomic Energy Levels", U.S. Nat. Bur. of Stand. Circular No. 467 (1949).

[2] Paschen, F., *Ann. d. Phys.*, **12**, 509 (1932).

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A Small Grading Temperature Apparatus for Entomological Use

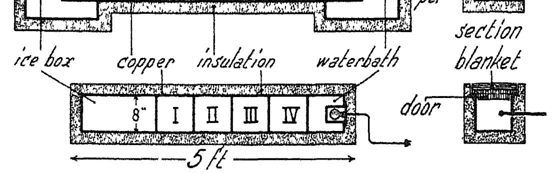
I HAVE devised an inexpensive grading temperature apparatus (or 'multiple incubator'), especially for a range of below-room-temperatures, for example, + 7°, + 13°, + 17·5° C., which otherwise would require three different refrigerators with thermo-regulation. This is based on the 'Brueckenthermostat' of Zwoelfer[1], and although much simpler, gives excellent results.

The original grading temperature apparatus consists of a copper trough, divided into six (or eight) compartments. One end is welded into an ice-box, the other into a water-bath, in which the temperature is controlled by a thermostat. The copper trough, which is insulated, lies on one side (⊏), and each compartment is closed by a small door, which contains three or four layers of glass. The temperature-range of an apparatus of this construction usually covers the temperatures 7, 13, 17·5, 22, 26·5 and 32° C. Its cost amounts, in Holland, to about £300.

In order to cut costs in materials and man-hours, it was decided to simplify the outlay in several ways: (1) temperatures above mean room temperatures are easily obtained by a simple incubator with thermostatic control; (2) the copper trough is kept upright (⊔), thus preventing cold air flowing from the compartments when the doors are opened, and simplifying the closing mechanism; (3) by incorporating the ice-box and the hot water-bath in the trough itself and not welding it into these parts. The accompanying diagrams show the original construction and the simplified outlay. The cost of the simplified construction amounts in Holland to about £12.

The apparatus is built of 1-mm. copper plate, the upper sides of the trough being set at an angle of 90° in order to strengthen the construction. It contains only four compartments for below-room temperatures, which shortens the apparatus considerably, thus cutting costs for raw material. The trough is placed in a wooden cradle and insulated with 'Excelsior', this being the cheapest insulating material available. The trough is closed with 'Celotex' board, each piece of board covering two compartments. Finally, a blanket is put on top of the whole apparatus. The thermometers, one in each compartment, protrude through the insulation at one side of the cradle.

The ice-box needs filling twice a day, thus keeping the first compartment at 7 ± 0·5° C.; the central compartments show an even smaller deviation. The hot water-bath may be controlled by a thermostat at the temperature wanted. The simplified apparatus, constructed at the Zoological Department of the University of Utrecht, is mounted in a cellar, at a mean temperature of 18 ± 0·5° C., the fluctuations in the apparatus being about the same order, without any thermostatic control being used.



Upper diagram, usual construction of grading temperature apparatus; lower diagram, simplified construction of apparatus

A 15-watt electric light bulb, which is built into the water-bath, keeps the hot side of the apparatus at 25·5° C., giving a range of 7, 13, 17·5 and 22° C.

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Zoological Department,
University of Utrecht. Oct. 11.

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Statistical Analysis of Results for Successive Tests on the Same Organism

A RECENT paper by Emik[1] demonstrates a method of dealing with counts of trichostrongylid eggs in the fæces of sheep. The method given is fundamentally wrong and in fact makes the paper so misleading that it seems worth outlining a more appropriate statistical treatment. The data were accumulated in a survey of the worm-egg numbers in the fæces of the lamb flock at the University of California. Trichostrongylid eggs were counted in fæces samples by a technique modified from that of Caldwell. Samples were taken once a week for twelve weeks and duplicate dilutions examined.

The counts per 0·02 gm. of fæces (x) were transformed to $\sqrt{x + \frac{1}{2}}$ and the transformed data used to calculate the variance of the differences between duplicate dilution counts. This variance agreed well enough with the theoretical variance, so the next step was to add together the duplicate counts on each sample and transform this total $(x_1 + x_2)$ to $\sqrt{x_1 + x_2 + \frac{1}{2}}$. No reason is given for making this new transformation; it does not seem worth the extra trouble involved. The variance of these transformed data was then calculated and analysed.

The fundamental error in this analysis is not uncommon in biometric literature[2,3] and has been attacked by Anscombe[4] and by Cochran[5]; it arises from regarding successive tests on the same animal as independent. The twelve weekly counts on the same sheep have been treated as the items of an independent variate called 'weeks'; the variance has been analysed into a portion due to variation from week to week and into portions due to the interactions of 'weeks' with the main effects. Not only is the assumption of independence a logical error, but also it is quite clear that in this case the 'weeks' portion of the variance consists very considerably of co-variance between one week and the next.

The practical consequences of this error are twofold, namely, that the error variance becomes too small, giving undue significance to items that are compared with it in the F-test; the second consequence is that the statistician is led into examining factors which have no practical meaning and into making statements such as "the sex × weeks interaction was not significant within the classes, but the class × weeks interaction was significant within the sexes".

On the data given by Emik (Table 1) the appropriate analysis of variance should be the following:

	Source of variation		Degrees of freedom
1	Sex		1
2	Breed and sires		6
	2a Sires within breed	2	
	2b Class of breed	1	
	2c Breed within class	3	
		6	
3	Sex × *2a*, *2b* and *2c*		6
4	Error		87
	Total		100

This should be worked on the average of the transformed egg counts for each sheep; the statistical method appropriate to this set of data is that of 'fitting constants'. Detailed criticism here would serve no useful purpose. One might, however, suggest that the analysis set out above would be illuminated by a table showing the size of the main effects and a graph showing trends during the twelve weeks of the observations. These were not given in the original paper.

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Oct. 6.

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[2] McQuillan, M. T., Trikojus, V. M., Campbell, A. D., and Turner, A. W., *Brit. J. Exp. Path.*, **29**, 93 (1948).

[3] Swanson, R. G., and Knodt, C. B., *J. Dairy Sci.*, **32**, 257 (1949).

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[5] Cochran, W. G., *J. Roy. Stat. Soc.*, Supp., **6**, 104 (1939).

Fruiting of *Coprinus lagopus* in Pure Culture

AN isolate of *Coprinus lagopus* from a compost of barley straw was observed to produce sporophores on slants of cellulose agar. The medium consisted of 5 gm. filter paper (Whatman No. 1) treated according to Scales[1] and incorporated in the following:

$NaNO_3$	1·0 gm.	H_2O	500 ml.
KH_2PO_4	0·5 gm.	Agar	7·5 gm.
KCl	0·25 gm.	$FeSO_4$	0·005 gm.
$MgSO_4$	0·25 gm.		

Incubation was at 25° C.

Since agar is known to supply growth substances[2], an attempt has been made to discover some conditions for fruiting in liquid media.

Strips of filter paper were half-immersed in 20 ml. of a solution of the mineral salt constituents of the cellulose agar. After sterilization, the filter paper was inoculated with *C. lagopus* above the level of the liquid, and the tubes incubated at 25° C. Growth was feeble, and after prolonged incubation there was no development of sporophores.

Fruiting of the fungus on the straw of the compost suggested that this material supplied a necessary factor for the process. An extract was prepared by steaming 50 gm. of straw in 500 ml. of water for 1 hr. After being filtered and autoclaved, the extract was incorporated in the solution supplied to the fungus with the filter paper, so that the original mineral salt contentration was maintained.

Development of the mycelium under these conditions was rapid, and after eight days incubation at 25° C. fruiting bodies began to appear. By the seventeenth day the first sporophore in each tube had deliquesced and was fully mature.

It would appear that the extract supplies some factor essential for fruiting of *C. lagopus* under these conditions. An attempt to determine the nature of this factor is now in progress, and details of the work will be published in due course.

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Oct. 8.

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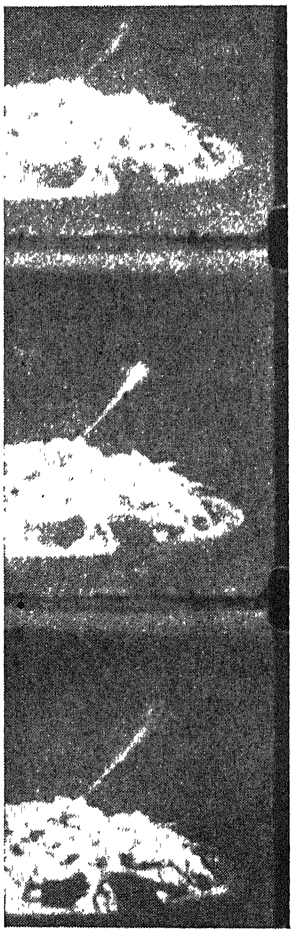
[1] Scales, *Zentralbl. f. Bakt.*, Abt. 11, **44**, 661 (1915).

[2] Robbins, *Amer. J. Bot.*, **26**, 772 (1939).

Dispersal of Antherozoids in *Fegatella*

IN *Fegatella conica* (Conocephalum) the antherozoids are vigorously dispersed by ejection into the air, and mites, usually considered to be the agents of transmission, probably play little if any part, at least in this member of the Marchantiales. This conclusion is the result of a chance observation made while attending to locally collected material of male plants of *F. conica* which had been transplanted into pans, and had dried considerably during a hot week-end. When watered, a fine mist arose; little attention was paid to this, until it was noticed that the mist was being emitted from the antheridial heads in regular puffs. Removal into direct sunlight increased the activity, and the particles which were being ejected were visible to the naked eye, so that the puffs were obviously composed of distinct granules.

Petri dishes inverted over the material were soon spattered with small droplets, which were found under the microscope to contain numerous coiled antherozoids, many of which were seen to uncoil and swim away in the film of moisture. Repeated collections of droplets were all identifiable as swarms of antherozoids, and it was realized that this explosive method was probably the means of transporting the antherozoids from the sessile antheridial heads to the stalked archegonial heads. Measurements showed that the ejection force was sufficient to perform this function, as antherozoids were thrown 10–15 cm. into the air when undisturbed by lateral air currents. In unscreened plants, however, air currents caused lateral diffusion, so that puffs were much less distinct, indicating that this phenomenon might easily be overlooked in the field.



Antherozoids being vigorously ejected into the air in a jet from a male head (× 6)

(From film by F. Ryan)

Plants were photographed on 16-mm. ciné film, and by careful screening frequent ejection from antheridia were recorded. Further observations showed that: (*a*) temperature was the stimulus to ejection; (*b*) light itself has no obvious effect; (*c*) moisture is a necessary condition for ejection; (*d*) mechanical stimulus can produce weak activity (probably the role taken by mites); (*e*) ejection of complete antheridia occurs.

It is hoped to deal with further observations on such points as these in a more detailed account to be published later.

Note added in proof. Since writing the above, I find that Cavers (1903) gives essentially the same description for this species ; so apparently did King (1903). Anderson's (1931) account of a non-explosive type of liberation in *Marchantia* seems improbable, since her observations were confined to sections immersed in water.

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Effect of Microclimate on the Establishment of Timothy Grass

PERMANENT quadrat studies on the establishment of timothy grass (*Phleum pratense*) and white clover (*Trifolium repens*) in 1947 and 1948 showed that timothy seedlings frequently dried up during hot spells. It was noticed that small seedlings growing close to larger ones or among white clover often remained healthy whereas others surrounded by bare ground died. The apparent explanation, for which support was given by Geiger's[1] work, lay in the protection afforded by vegetative cover. Among other effects cover would lower evaporation from the top layer of soil and prevent temperature and humidity conditions from becoming extreme.

In 1949, dry hot weather set in early, and by mid-June, when the largest late-April-sown seedlings had two or three tillers, many seedlings at the two- or three-leaf stage were dying off in exposed areas. Root measurements showed that the smallest healthy seedlings in the exposed areas had roots of about 2 cm. long. Those with shorter roots averaging 1·7 cm. were dead or dying. In the denser areas the smallest seedlings with roots about 1·6 cm. were quite healthy. Very dense areas where overcrowding introduced another factor are not considered. At this point microclimate studies were started to find out the extent of the protection given by a cover of young tillering plants.

Rough soil moisture figures showed that the top half-inch of exposed soil several times dried out to about 5 per cent water, which was well below wilting point (10 per cent). The top half-inch of covered soil dried out to only just below wilting point.

Soil temperature gradients were studied in both exposed and covered areas. Several typical gradients through different types of cover on a sunny, though windy, afternoon in August are shown in the accompanying graphs.

The main heating effect is seen to occur at the outer active surface or where the sun's rays strike the ground or leaf cover. An example is given in Table 1 of the degree of protection from insolation afforded to the delicate growing parts of young seedlings.

Table 1 TEMPERATURE GRADIENTS—11.0 A.M.—SUNNY DAY, AUGUST 22, 1949

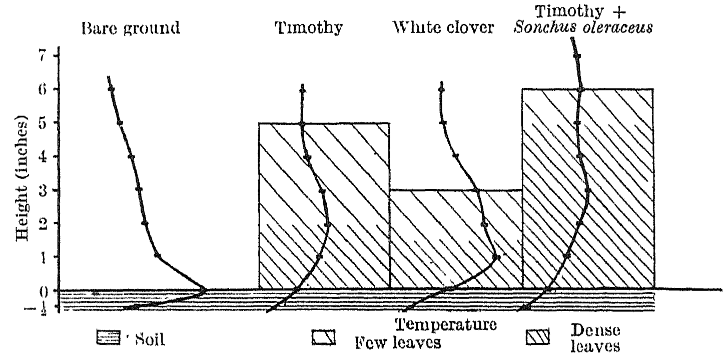
Height	Bare ground	Ryegrass/white clover cover
3 in. above soil surface	28·5° C.	27·8° C.
2 in. „ „ „	28·8° C.	29·5° C.
1 in. „ „ „	30·5° C.	27·4° C.
Soil surface	35·0° C.	25·0° C.
½ in. below surface	28·5° C.	23·0° C.

Table 2. SOIL TEMPERATURE IN RELATION TO SOIL MOISTURE

	Percentage water in top ½ in. soil	Temperature		
		1 in above surface	Surface	½ in. below surface
Bare ground, dry	8 5	27 0° C.	35·9° C.	30·8° C.
Bare ground, watered	15·2	26·7° C.	28 8° C.	26 0° C.

The inter-relationship of moisture and temperature is shown in Table 2 by a comparison of temperatures of an area after three days watering with an unwatered area.

These microclimate studies will be extended in 1950 to include humidity measurements. It can be assumed that there will also be considerable differences in humidity between the exposed and covered areas.



Curves of temperature gradients in vegetation of different heights. August 8, 1949; air temperature at 12 in., 23° C.; sunny; moderate wind

It is not yet possible to determine the limiting factor or factors in the survival of timothy seedlings during drought. It is clear, however, that differences in microclimate between areas with exposed soil and those with plant cover are sufficient to account for the higher mortality among the more sparsely spaced seedlings.

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Jan. 10.

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Reclamation of 'Usar' Lands in India through Blue-green Algæ

WHILE other plants, including crops, fail to grow on the alkaline 'Usar' lands of northern India, blue-green algæ form a thick stratum on the surface of the soil during the rainy season (from July to September) and during the retreating monsoon (December–January). The most important algæ are species of *Nostoc* (*N. commune*, *N. muscorum*, *N. punctiforme*), *Scytonema* (*S. ocellatum*, *S. javanicum*), *Microcoleus* (*M. chthonoplastes*, *M. vaginatus*), *Porphyrosiphon* (*P. Notarisii*), *Camptylonema* (*C. lahorense*), and *Cylindrospermum* (*C. licheniforme*, *C. muscicola*). In later stages, when the soil is waterlogged, forms like *Aulosira fertilissima*, various species of *Anabœna*, *Cylindrospermum gorakhporense* and *Wollea Bharadwajœ* make their appearance. *Nostoc commune*, which covers many miles, fulfils an especially striking role. The annual addition of organic matter to the soil is of the order of 36·5–59·7 per cent and that of nitrogen, 30–38·4 per cent. Although the nitrogen-fixing capacity of *Nostoc commune* and of other species is still being investigated in bacteria-free cultures, results so far obtained suggest such fixation, which has already been established in certain forms[1–4]. The numbers of *Azotobacter* appear to be considerably reduced in these soils.

The actual process of reclamation is as follows. During May and June, before the commencement of the rains, the land is divided into plots of less than an acre. These are then enclosed on all sides by an earth embankment, 1½ ft. high. After the first showers, the first group of algæ above mentioned appear on the surface, and within a fortnight or so form a thick and compact stratum. Later, when the ground is waterlogged, the algal carpet may become detached and float on the surface of the water. The first are then gradually replaced by the second set of algæ, which continue active growth as long as water remains. This process could be repeated several times in a year if irrigation water were available. Under existing conditions, however, reclamation can only be undertaken in the rainy season.

Field trials have already been carried out in two villages in the Benares district. After a year of reclamation a transplanted paddy crop, grown in the subsequent year, produced a yield of 1,576–2,000 lb. per acre. In the third year a Coimbatore variety of sugar-cane was successfully grown, with an average yield of 30–35 tons per acre. After the first year, the *p*H of the soil fell from 9·5 to 7·6, while there was an improvement in tilth and of the exchangeable calcium by about 20–33 per cent. The water-holding capacity increased by about 40 per cent.

In view of the vast area occupied by such waste lands in the United Provinces alone, the suggested method of reclamation promises to be of immense practical value to Indian agriculture.

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African Elephants as Geological Indicators

DURING two and a half decades of African bush geology, an observation has forced itself upon me which may perhaps have been noticed by others, namely, that elephants appear to show preference for certain geological horizons. This is at times so well pronounced that the boundary line between two formations can be deduced from native information as to how far elephants circulate in the district. I have noticed it particularly in regions where crystalline rocks, mainly granite masses, come into contact with sandstone, and it is the latter which the elephants prefer.

The first locality, where indeed the boundaries of the granite could be marked according to these observations, was the country between Mouyondzi, Sibiti and Loudima, west of Brazzaville, in the French Middle-Congo, the formations involved being the "Grès de Sibiti", the Upper Kundelungu and the granite mass of Zanaga.

The second district where it was well marked was eastern Oubangui-Chari, towards the border of the Anglo-Egyptian Sudan. Here the escarpment formed by the Ouadda sandstones, generally classified as Loubilashe, formed the definite margin towards the crystalline country of Dar Challa (Ouandadjale).

The third time I came across this phenomenon was in French Adamaua, Northern Cameroons. Here it is the boundary line between the Benoue sandstones and the crystalline and young volcanic rocks of Ngaoundere and Rey-Bouba, roughly 40 km. south of Garua.

In some cases, as to a certain extent within the Forest of Sibiti, where the decomposition of sandstone gives rise to dense vegetation, the question explains itself. Otherwise, however, the country was either tree-savanna or light bush, and in such cases the reason is difficult to explain. It might be a question of food, chemical composition of water or nature of the weathering soil.

It would be interesting to have comments from Central and East Africa, also from the Gold Coast, with reference to the boundary between sandstones of the Voltaian and crystalline rocks of the Northern Territories.

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Mode of Action of Insecticides used for the Control of Apple Sawfly, *Hoplocampa testudinea*, Klug.

Hey and Steer[1] have expressed the belief that nicotine acts mainly as an ovicide when used for controlling apple sawfly, though it is also toxic to the larvæ. They quote, however, other authors who believe that nicotine does not kill the eggs of the sawfly. In an attempt to resolve this conflict of views, ten to fifteen stung blossoms from each of the treatments of a field trial for the control of apple sawfly were examined daily in order to find out at which stage the pest was killed. The treatments, applied in the first post-blossom lime-sulphur spray on May 10, 1949, were as follows: 0·05 per cent nicotine, 0·02, 0·005 and 0·00125 per cent, respectively, parathion (diethyl *p*-nitrophenyl thionphosphate).

No eggs hatched until May 17; peak hatch was on May 19 or 20, and hatching was almost complete by May 23. No larvæ were found dead within the egg in blossoms from any of the treatments, but all were alive and active right up to the point of hatch. After hatching, the effects of the various treatments became noticeable. In the blossoms taken from trees receiving the highest concentration of parathion, the larvæ were found lying dead or moribund near, or within, the remnants of the egg shell. As the concentration of the parathion was decreased, the larvæ lived for progressively longer periods after hatching, and in the case of the weakest concentration two larvæ were found to have entered and burrowed normally. Larvæ in fruitlets from trees sprayed with nicotine were found to burrow normally.

These observations are supported by the data for the sawfly infestations on the recorded trees, which, expressed as a percentage of the total fruit set, were: 50·6 per cent in the controls, and 2·6, 12·9 and 23·9 per cent respectively in the blocks of trees receiving 0·02, 0·005 and 0·00125 per cent parathion. The nicotine sprays gave no control.

It is apparent that nicotine and parathion under field conditions are not acting as ovicides, but kill the larvæ in the period between emergence and entry into the fruit. Thus for successful sawfly control, the insecticide must either be applied as close as possible to peak hatch, or must have sufficient residual effect to cover the whole hatching period. Nicotine is of the first type, and although, in at least some seasons, it may be applied a few days before hatching commences and still give satisfactory control, there is a very small safety margin, especially if it is to be applied in the first post-blossom lime-sulphur spray. It would seem more convenient to choose an insecticide with a greater residual action. It is hoped that details will be published later of work which has been done, and is continuing, at this Station to find which is the best of the new residual insecticides.

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Nov. 2.

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[1] Hey and Steer, Ann. Rep. East Malling Res Station, 197 (1933). Steer and Thomas, Ann Rep. East Malling Res. Station, 194 (1934).

An Enteropneust Genus New to the British Isles

While digging in sandy gravel beyond the apparent low-water mark, on the west coast of Anglesey, during the spring tides at the end of August 1949, a small Enteropneust was found in a burrow of fine sand adhering to a stone. Afterwards several more were discovered in an adjacent, more sheltered region of the shore, where the sand contained a fairly high percentage of organic material.

The animals live in coiled burrows at depths down to four inches, and in association with *Cereus pedunculatus* (Pennant), *Perinereis cultrifera* (Grube), *Arenicola marina* (Montagu), *Notomastus latericeus* (Sars), *Audouinia tentaculata* (Montagu), *Peloscolex benedeni* (O. F. Müller), *Clitellio arenarius* (O. F. Müller).

The primitive condition of the cœlom, namely, one proboscis cavity, two collar cavities, and two trunk cavities, the persistence of dorsal and ventral mesenteries throughout the last two regions, the absence of perihæmal and peripharyngeal cavities in the collar, and of lateral septa in the trunk, of synapticulæ between the gill bars, and of liver diverticulæ, the simplicity of the skeletal system, and of the pharyngeal region, the absence of genital wings and the lateral disposition of the gonads in single rows, justify the identification of this species as one closely related to the genus *Balanocephalus* originally described by Caullery and Mesnil[1] from Saint Martin near Cap de la Hague. Finding this name to have been previously used, these workers gave a detailed description of their species under the generic name of *Protobalanus*[2]. Unfortunately, this too had been previously used for a fossil balanid, so Van der Horst suggested the name *Protoglossus*, under which he summarizes the specific characters in his treatise on the Hemichordata[3].

This find extends the records of Enteropneusta found around the coasts of Britain to six, namely, *Saccoglossus ruber*[4], *S. serpentinus*[5], *S. cambrensis*[6], *S. horsti*[7], *Glossobalanus marginatus*[8], and the new species now recorded.

From my experience of collecting the various British species of *Saccoglossus*, it seems that they favour areas where the substrate contains a fair amount of organic material. Such areas, usually adjacent to beds of *Spartina*, *Zostera* or other shore-living plants, have previously yielded three species of *Saccoglossus*, and if more extensively worked, might well yield more.

A full description of this new species, and of certain species of *Saccoglossus* as yet inadequately described, along with a review of the genus, are to be submitted for publication shortly.

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Bangor. Oct. 17.

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British Freshwater Harpacticids

One of the rarest of the freshwater species of the British Harpacticids is *Canthocamptus bidens* (Schmeil); but it has a very wide distribution abroad. However, until quite recently, the males had never been found either in the British Isles or abroad.

Last June, I discovered a large number of specimens of the species in question in a lake in the grounds of Wellington College, Crowthorne, in Berkshire, and the males were just as abundant as the females.

There has been a considerable difference of opinion over the taxonomy of this species. In 1929 Chappuis created a new genus *Elaphoidella* and placed *Canthocamptus bidens* (Schmeil) in that genus. All taxonomists, so far as I am aware, followed Chappuis, with the single exception of Gurney, who not only disagreed with the creation of the new genus but also pointed out that there was no justification whatsoever for placing *C. bidens* in that genus, especially since the genus was founded almost entirely of the characteristics of the males. The recent discovery of the males and the structure of the fifth foot, among other things, have shown beyond question that Gurney was right so far as the taxonomy of *C. bidens* is concerned.

A description of the male of *C. bidens* is in the press. Full reference to the literature concerned can be found in "British Freshwater Copepoda", vol. 2, by Robert Gurney (Ray Soc. Memoir, 1932) and "Monographie der Harpacticiden", by Karl Lang (Stockholm, 1948).

Ashley G. Lowndes

The Laboratory,
Citadel Hill,
Plymouth.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, February 27

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE (joint meeting with the SCIENCE MASTERS' ASSOCIATION, the ASSOCIATION OF WOMEN SCIENCE TEACHERS, the B.B.C., the NATIONAL INSTITUTE OF ADULT EDUCATION, and the WORKERS EDUCATIONAL ASSOCIATION, at the Royal Institution, 21 Albemarle Street, London, W.1), at 5.30 p.m.—Discussion on the "History of Science in Education".

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Mobile Radio Power-Packs" (to be opened by Air-Commodore R. L. Phillips).

UNIVERSITY OF LONDON (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p m.—Prof. J. W. Bigger: "Synergism and Anatagonism in relation to Antibacterial Substances".*

INSTITUTION OF WORKS MANAGERS, GLASGOW BRANCH (at the Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow), at 7 p m.—Dr S. I. A. Laidlaw: "Occupational Health as a part of the Provisions of a Public Health Department".

CHEMICAL SOCIETY, OXFORD SECTION (in the Physical Chemistry Laboratory, Oxford), at 8 15 p.m.—Sir John Lennard-Jones, F.R.S.: "Some Unifying Concepts in Chemistry" (Alembic Club Lecture). (All Fellows are invited.)

Tuesday, February 28

INSTITUTE OF SOCIOLOGY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5 30 p.m.—Prof. W. J. Rose: "Antagonism to Strangers—Theory and Fact".

INSTITUTION OF ELECTRICAL ENGINEERS, NORTH-WESTERN CENTRE (at the Engineers' Club, Albert Square, Manchester), at 6.15 p.m.—Dr. A. C. B. Lovell. "Radar Astronomy" (Fifth Annual University Lecture).

MANCHESTER GEOGRAPHICAL SOCIETY (at the Geographical Hall, 16 St. Mary's Parsonage, Manchester), at 6.30 p.m.—Mr. L. Milner: "Rhineland To-day".

SHEFFIELD METALLURGICAL ASSOCIATION (at 198 West Street, Sheffield), at 7 p.m.—Mr. J. Rhodes: "The Non-Destructive Testing of Metals".

Wednesday, March 1

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m —Prof. G. E. Blackman: "Selective Toxicity and the Development of Selective Weedkillers" (Inaugural Fernhurst Lecture).

ROYAL SOCIETY OF MEDICINE, HISTORY SECTION (at 1 Wimpole Street, London, W.1), at 4.30 p.m —Prof. J. R. Partington: "Van Helmont's Chemical Work in its relation to the Rise of Physiology".

MANCHESTER METALLURGICAL SOCIETY (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Mr. J. W. Cuthbertson: "Continuous Casting of Metals".

INSTITUTION OF ELECTRICAL ENGINEERS, SCOTTISH CENTRE (at the Heriot-Watt College, Edinburgh), at 7 p.m.—Prof. G. W. O. Howe: "Some Electromagnetic Problems". (To be repeated on Tuesday, March 14, at the Electricity Showrooms, High Street, Rugby, at 6.30 p.m, and on Monday, May 1, at the James Watt Memorial Institute, Great Charles Street, Birmingham, at 6 p.m.)

CHEMICAL SOCIETY, EIRE SECTION (joint meeting with the IRISH CHEMICAL ASSOCIATION, the ROYAL INSTITUTE OF CHEMISTRY and the SOCIETY OF CHEMICAL INDUSTRY, in the Department of Chemistry, University College, Dublin), at 7.45 p.m.—Prof. M. Stacey: "Deoxy-Sugars and Nucleic Acids".

Thursday, March 2

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5 p.m.—Prof. Alfred Tarski: "Fundamental Ideas and Problems in Meta-Mathematics" (Shearman Memorial Lectures).* (Further Lectures on March 3, 7 and 8.)

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENTS SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. F. J. Woodcock. "Some Electrical Methods of Measuring Mechanical Quantities".

ROYAL SOCIETY OF MEDICINE, UNITED SERVICES SECTION (at 1 Wimpole Street, London, W.1), at 5.30 p.m.—Surgeon-Comdr. G. M. Holford: "Some Aspects of Atomic Medicine".

CHEMICAL SOCIETY, HULL SECTION (joint meeting with the ROYAL INSTITUTE OF CHEMISTRY, at University College, Hull), at 6 p.m.—Dr. G. M. Bennett, F.R.S.: "Aromatic Nitration".

CHEMICAL SOCIETY (in the Main Chemistry Lecture Theatre, Imperial College of Science and Technology, South Kensington, London, S.W.7), at 7.15 p.m.—Prof. Dr. Pl. A. Plattner (Zürich): "The Azulenes" (Centenary Lecture).

TEXTILE INSTITUTE (at 16 St. Mary's Parsonage, Manchester), at 7.15 p.m.—Gladys G. Clegg: "Microscopical Examination of Fibres from Worn Fabrics".

Friday, March 3

ROYAL ASTRONOMICAL SOCIETY (joint meeting with the GEOLOGICAL SOCIETY, at the Geological Society, Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Geophysical Discussion on "Gravity as a Geological Factor".

CHEMICAL SOCIETY, SOUTHAMPTON SECTION (joint meeting with UNIVERSITY COLLEGE CHEMICAL SOCIETY, in the Physics Department, University College, Southampton), at 5 p.m.—Dr. H. Irving: "The Determination of Traces of Elements and Compounds".

PHYSICAL SOCIETY (at the Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Prof. G. I. Finch, F.R.S.: "The Sliding Surface" (Thirty-fourth Guthrie Lecture).

CHEMICAL SOCIETY, SOUTH WALES SECTION (joint meeting with UNIVERSITY COLLEGE STUDENTS' CHEMICAL SOCIETY, at University College, Swansea), at 5.30 p.m.—Prof. F. E. King: "Synthetical Investigations in the Series of Cyclic Imines".

BRITISH INSTITUTION OF RADIO ENGINEERS (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6.30 p.m.—Mr. R. L. Kompfner: "Travelling Wave Tubes".

CHEMICAL SOCIETY, MANCHESTER SECTION (in the Univer Manchester), at 6 30 p.m.—Prof. Dr. Pl. A. Plattner (Zurich): "T Azulenes" (Centenary Lecture).

PAPER MAKERS' ASSOCIATION, TECHNICAL SECTION, NORTHERN DIVISION (at the Engineers' Club, Albert Square, Manchester), at 7 p.m.—Mr. E. Langford. "The Functions of Personnel Management".

CHEMICAL SOCIETY, EIRE SECTION (joint meeting with the IRISH CHEMICAL ASSOCIATION, the ROYAL INSTITUTE OF CHEMISTRY and the SOCIETY OF CHEMICAL INDUSTRY, at University College, Cork), at 7.45 p.m.—Prof. M. Stacey: "Bacterial Nucleic Acids".

UNIVERSITY OF LONDON (at Royal Holloway College, Englefield Green, Surrey), at 8.15 p.m.—Prof. A. J. McConnell. "Sir William Rowan Hamilton". (Admission by invitation from the Principal.)

Saturday, March 4—Sunday, March 5

ASSOCIATION OF SCIENTIFIC WORKERS (at St. Pancras Town Hall, Euston Road, London, W.C.1).—Conference on "The World's Food and Britain's Needs".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN MATHEMATICS, a LECTURER IN ORGANIC CHEMISTRY, a SENIOR ASSISTANT IN MECHANICAL ENGINEERING, and a LECTURER IN COMMERCE, at the Coventry Technical College—The Director of Education, Council House, Coventry (March 1).

CHAIR OF AGRICULTURE, and a LECTURER IN PHARMACY, at the University of Ceylon—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (March 3).

RESEARCH ASSISTANT for investigations on bone histology—The Registrar, The University, Liverpool (March 4).

SENIOR SCIENTIFIC OFFICER or SCIENTIFIC OFFICER (Ref. F.51/50A), research chemist, or biochemist with analytical experience, for experimental work on food processing, a SENIOR SCIENTIFIC OFFICER or SCIENTIFIC OFFICER (Ref. G.14/50A), research microbiologist for experimental work on food processing, an EXPERIMENTAL OFFICER (Ref. F.52/50A), chemist or biochemist with analytical experience (preferably of foodstuffs) for experimental work on food processing, an EXPERIMENTAL OFFICER (Ref. G.15/50A), microbiologist for experimental work on food processing, an EXPERIMENTAL OFFICER (Ref. F.53/50A), food chemist with general factory experience, for development work on food processing, at the Ministry of Food, Aberdeen—The Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (March 4).

ASSISTANT IN BIOCHEMISTRY (preferably a chemistry graduate with some postgraduate experience in biochemistry)—The Dean, British Postgraduate Medical Federation Institute of Orthopædics, 234 Great Portland Street, London, W.1 (March 15).

OFFICER-IN-CHARGE, Commonwealth Research Station, Merbein, Vic. (No. 2728), work chiefly concerned with investigations into the many phases of viticultural and citrus production in the Mildura and surrounding area, and a SENIOR RESEARCH OFFICER (microanalyst), Division of Industrial Chemistry, Fishermen's Bend, Melbourne (No 2711)—The Chief Scientific Liaison Officer, Australian Scientific Research Liaison Office, Africa House, Kingsway, London, W.C.2 quoting the appropriate Ref. No. (March 18).

LECTURER IN THE DEPARTMENT OF BACTERIOLOGY—The Secretary, The University, Edinburgh (March 31).

DIRECTOR (with an honours degree in engineering and corporate membership of the Institution of Civil Engineers or Mechanical Engineers) in the Ministry of Supply, Division of Atomic Energy (Production), at Risley—The Administrative Branch, Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

HEAD OF THE CHEMISTRY DEPARTMENT, and a SENIOR ASSISTANT (male) well qualified to teach chemistry, particularly physical chemistry, to degree standard, and with industrial experience, at the Municipal Technical College—The Chief Education Officer, Education Offices, Nelson Square, Bolton.

LECTURER, and an ASSISTANT LECTURER AND DEMONSTRATOR, in the Department of Physiology—The Secretary, King's College of Household and Social Science, Campden Hill Road, London, W.8.

RESEARCH BURSARY IN THE DEPARTMENT OF ENGINEERING—The Registrar, The University, Nottingham.

SENIOR ASSISTANT (Biology), and a GRADUATE ASSISTANT (Physics), at the Wolverhampton and Staffordshire Technical College—The Clerk to the Joint Education Committee, Education Offices, North Street, Wolverhampton.

SOCIAL ANTHROPOLOGISTS, URBAN SOCIOLOGISTS, a DEMOGRAPHER and a HISTORIAN—The Director, Rhodes-Livingstone Institute, Box 195, Livingstone, Northern Rhodesia.

TSETSE CONTROL OFFICER by the Government of the Gold Coast—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.23338 (3F).

DEPUTY CHIEF ENGINEER to act as deputy to the Director (Chief Engineer) responsible for the design and layout of large chemical factory installations—The Ministry of Supply, Division of Atomic Energy (Production), Risley Warrington, Lancs.

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COLONIAL RESEARCH SERVICE

IN a speech in the House of Lords on November 30. Lord Tweedsmuir referred to the deterrent effect of political uncertainty and of misrepresentation on recruitment for the British Colonial Service. One factor in that situation has been the biased and unfriendly criticism in the Trusteeship Council and even at the General Assembly of the United Nations. Now we have the report of the visiting mission of the United Nations Trusteeship Council on the Cameroons under British administration giving a very different picture. The mission consisted of an Iraqi, a Belgian, a Mexican and an American, and it pays high tribute to the excellence of the aims of British Colonial administration and to the way in which those aims are being implemented. This report appeared very shortly after the appearance of the Colonial Office pamphlet, "Appointments in His Majesty's Colonial Service"[1], and the announcement on January 30 by Mr. D. R. Rees-Williams, Under-Secretary for the Colonies, of the formation of a Colonial Research Service, to take effect from January 1, 1949. All these factors should help to re-establish that professional esteem which must always be one of the intangible forces determining entry on such a career.

The new edition of "Appointments in His Majesty's Colonial Service" is indeed well designed for its purpose. It describes the standard of academic, professional or technical qualifications required for the wide variety of posts now available and gives just a hint of the imagination and common sense of a high order, the deep spirit of service and the wide humanity which are also needed if the great traditions of the past are to be upheld and the Colonial Service of to-day and to-morrow is to discharge the new tasks and responsibilities of the stage of partnership which is succeeding that of trusteeship. The transfer of more and more responsibility to the people of the Colonies themselves, and the giving of advice effectively, make even bigger demands on the Colonial officer; and to discharge such duties he needs not only the high ideals to which Mr. Creech Jones, the Secretary of State, refers in his foreword, but also in some measure at least the support and approval of informed world opinion.

Appreciations such as that contained in the report of the visiting mission to the Cameroons can therefore play an important part in supplementing the factual appeal of the Colonial Office pamphlet. This gives not only some account of the general conditions of service and salary-range and a summary of the various appointments dealt with by the Director of Recruitment (Colonial Service), the Overseas Nursing Association and the Crown Agents for the Colonies, but also a list of sources of information for certain appointments not within the Colonial Service and a short list of recommended books and papers. There is also appended a table showing the scale of recruitment during 1939–1948.

From the point of view of man-power, this is one of the features of the pamphlet of most general interest; and it is all the more so because the information contained in the pamphlet as to the size of the individual services is rather sketchy. While, for example, it is indicated that there are in the administrative service some 2,000 permanent appointments, in the agricultural service 550, in the medical service 800, in the forest service 200, in the prisons service 150, in the survey service 210, and in the audit service 140, for the chemical service, biological appointments, civil aviation service, customs service, education service, engineering service, fisheries appointments, geological survey service, mines service, veterinary service, and others no figures are given. We are told that labour appointments number 200 and meteorological appointments 40; but for the rest it is impossible to form any opinion of the size of the Service or of the proportion of any individual section to the whole.

What would have been welcome in this pamphlet is an indication of the proportion which scientific and technical persons now bear to the whole Service, and the extent of the demand which the annual intake now makes upon the trained man-power—and woman-power—of Great Britain. The scale appended to the pamphlet shows, indeed, that in 1947 and 1948, when in all 1,169 and 1,163 appointments, respectively, were made by the Secretary of State, appointments, presumably essentially scientific, accounted for 467 and 564, respectively. These figures take no account of broadcasting, commerce and industry, customs, economics, education and the like appointments, although some technical if not scientific appointments may fall in these groups. In 1946 the corresponding figure was 668 out of 1,695, as against 114 out of 270 in 1939.

While these figures may well include some appointments which are neither scientific nor technical, it seems probable that something of the order of forty per cent of the appointments to the Colonial Service are now to scientific or technical posts, and that the proportion has not greatly changed from before the War, although the number of appointments has increased four-fold. The increased proportion of scientific workers and technicians in the Colonial Service relative to the administrator goes back to an earlier period, and the important feature at the present time seems to be the increasing demand which the Colonial Service as a whole is making on the output of trained man-power and woman-power. That demand may be eased to some extent by technical co-operation with the United States as contemplated apparently by President Truman under the Fourth Point; but for any considerable decrease in the demand we will have to await the full flowering of the Colonial universities.

In the meantime, the vast field of inquiry open in the Colonial Empire for scientific discovery and research may well increase the demand for men for scientific research in those under-developed territories. The African Regional Scientific Conference last year testified to the immense opportunities in this respect in Africa south of the Sahara, above all for investigations on the spot. In the Press conference on January 30 at which the formation of a Colonial Research Service was announced, Mr. J. C. Hibbert, the head of the Research Department, stressed the great openings and scope which the new Service offers to young people. While the Colonial Office has taken the fullest advantage of the assistance of such bodies as the Department of Scientific and Industrial Research, the Medical Research Council and the Agricultural Research Council, much research has to be carried out on the spot. In the past two years ten major and about fifty subsidiary research appointments were made; but another four hundred will probably be made during the development of the Service. The Service will not include officers who are appointed specifically to posts in the United Kingdom: such officers will be considered temporary or permanent members of the United Kingdom Scientific Civil Service.

Mr. Rees-Williams said that the object is to create a service with salary scales, terms of service and standards comparable with those enjoyed by research workers in Great Britain and which would offer the research worker the possibility of a continuous pension whether the whole or only a part of his career is spent in the Colonial Empire. The new scheme is designed to link together the scattered research workers in the Colonies and is intended to meet the needs, not only of those who propose to carry out their life's work in the Colonial territories, but also the home research worker going overseas for a few years, and the Colonial research worker who wishes to work in Britain for a few years. The Service was evolved by the Colonial Office in collaboration with scientific men at home and abroad and after consultation with the Colonial Governments. The terms and conditions of service are set out in a pamphlet entitled "Appointments in His Majesty's Colonial Research Service"[2], obtainable from the Colonial Office, which also includes details of recruitment arrangements in Canada, Australia, New Zealand, South Africa and Southern Rhodesia, and of the Colonial Research Fellowships to be granted during 1949–53. Candidates will be selected by competition based on personal interview and record, taking full account of academic attainments, health, character, personal fitness, and (where applicable) professional qualifications and civil employment. Superannuation will be provided under a contributory Colonial superannuation scheme to be introduced later this year, and the scheme will provide for some interchange between the Colonies, and for the establishment of regional organisations rather than small research institutes in every Colony. Stress was laid at the Press conference on the need for soil scientists, entomologists and fishery research workers, Dr. C. F. Hickling, fisheries adviser to the Colonial Office, emphasizing the world-wide shortage of the latter and the great scope for fish farming.

While no more than a rough estimate can as yet be formed of the extent to which the Colonial Research Service will affect British resources of scientific man-power, it is clear from this first statement that the scheme is designed imaginatively and will meet some of the real problems of the overseas research worker. Its provision for superannuation and for interchange should go far, by encouraging mobility and sabbatical leave, to break down the isolation which has been such a handicap to the Colonial scientific worker in the past. If it should prove, furthermore, that the report of the visiting mission to the Cameroons betokens a wider appreciation of the work of the whole Colonial Service, there is every reason to hope that, with the new conditions of service, the Colonial Office will no longer find itself unable to obtain sufficient recruits of the high quality desired for its Research Service or for any other branch.

[1] Colonial Office. Appointments in His Majesty's Colonial Service. Pp. 111. (London: H.M. Stationery Office, 1950.) 1*s*. net.

[2] Colonial Office. Appointments in His Majesty's Colonial Research Service. Pp. 15 (London: Colonial Office 1950.)

ADVANCES IN ENZYMOLOGY

Advances in Enzymology and Related Subjects of Biochemistry

Edited by F. F. Nord. Vol. 8. Pp. xi+538. 48*s*. Vol. 9. Pp. x+760. 54*s*. (New York and London: Interscience Publishers, Inc., 1948 and 1949.)

THESE two volumes contain twenty-two articles on a variety of subjects of enzymological and biochemical interest. They vary from a study of the function of cytoplasm to a discussion on industrial biosynthesis. They consist of authoritative essays, some of them extensive monographs, in special fields of biochemistry, and they well uphold the high standard set in previous volumes of "Advances in Enzymology".

Dr. Ludwik Monné gives a critical review of recent literature dealing with the structure of protoplasm, and he attempts to portray a consistent picture of the functioning of cytoplasm. He describes investigations on chromidia and shows how new work has demonstrated that ribonucleic acid is present within the cytoplasm (in the chromidia) and that thymonucleic acid is in the chromosomes. Chromidia and mitochondria differ from each other, the latter lacking ribonucleic acid. Nucleic acids appear to be concerned with mechanisms of protein synthesis, and it is claimed that "self-perpetuating corpuscles must be nucleoproteins". The chromidia are an organised system of chemical compounds and are self-perpetuating bodies similar to chromatin. Dr. Monné proceeds to compare various living fibrils and discusses plasma membranes, mitochondria, Golgi bodies, chloroplasts and cell organisation. An interesting and stimulating discussion of the metabolic activities of the cell follows, with comments on contractility, mobility, irritability, conductivity and permeability.

Drs. M. A. Lauffer, W. C. Price and A. W. Petre write on the nature of viruses, dealing with the plant and bacterial varieties. Virus mutations are discussed, and it is pointed out that studies on inheritance in viruses have shown that these entities are more highly organised than genes. They contain, in fact, a number of genes or gene-like structures. Great progress has been made in the last decade on the elucidation of the nature of viruses, the impulse being given by the crystallization and characterization of tobacco mosaic virus. Later work showing that this is a nucleoprotein has resulted in the application of the new techniques to purification of many other viruses. Details are given of their physical constants, and shadow electron micrographs of virus particles are included. All the plant viruses, as well as some of the animal viruses, seem to consist of nucleoproteins; others, like vaccinia virus, also contain fat and carbohydrate. Tobacco mosaic virus consists of sixteen to eighteen amino-acids, the number depending upon the strain.

A most informative article on the chemistry and enzymology of nucleic acids is contributed by Dr. F. Schlenk. This is particularly useful in view of the paucity of comprehensive reviews and monographs on the subject. The compounds discussed are classified into two main groups: one comprising ribo- and desoxyribo-nucleic acids and their split products; and the other comprising co-enzyme nucleotides such as adenine, riboflavin and nicotinamide nucleotides. The nucleotides are defined as the phosphoric acid esters of the nucleosides. The latter are the N-glycosides of naturally occurring bases, the carbohydrate being *d*-ribose, *d*-2-desoxyribose or some closely related sugar. The nucleic acids or polynucleotides are not yet clearly defined, and it is preferable at present to use the non-committal terms of ribonucleic acid and desoxyribonucleic acid, these being understood as collective terms, since evidence is appearing that each type is collective in nature. Dr. Schlenk discusses aspects of the metabolism of the constituents of nucleic acids, and describes recent spectrophotometric studies of these substances, pointing out the value of the application of spectrophotometry to enzyme and cytoplasmic studies. The enzymes hydrolysing the nucleosides, nucleotides and nucleic acids receive considerable attention, and a most interesting discussion is given of the architecture of the nucleic acids. It is emphasized that a new development in the nucleic acid field is the tendency to question the existence of distinct tetranucleotides as structural units of nucleic acids. In spite, however, of the increased interest in the chemistry and enzymology of nucleic acid, research activity in this field needs intensification. It is possible that this may take place now that well-defined substrates (nucleosides, nucleotides and nucleic acids) are becoming available for enzyme studies.

One of the most important and interesting articles in the series under review is that by Dr. T. Mann on the metabolism of semen. This subject, to which Dr. Mann has, himself, contributed much of great value, has become of considerable significance, and doubtless will achieve greater importance as time goes on. Dr. Mann points out that although it is true that the best way to prolong the life-span of sperm cells is to reduce their motility and metabolism, say, by lowering the temperature, the mammalian spermatozoa are to a large extent independent of the small nutrient reserve they possess. They obtain their energy by assimilation and metabolism of fructose present in the seminal plasma. So far as nutrition is concerned, the spermatozoa "resemble more a culture of microorganisms in a nutrient medium rather than the other animal tissues with their complicated supply of nutrient material via the blood capillaries". Another characteristic of the sperm cell is its remarkably high permeability, which accounts for the high velocity of the exchange reactions taking place between the sperm cells and surrounding medium. Moreover, large molecules, for example, enzymes such as hyaluronidase, can detach themselves from the sperm structure and are released into the outer medium. Perhaps such phenomena are involved in the fertilizing function of the spermatozoa. A detailed account is given of the constituents making up semen, with particular reference to sperm nucleic acid and adenosinetriphosphate and to such enzymes as hyaluronidase and phosphatases. Fructose and fructolysis in sperm metabolism receive close attention. There seems little doubt that oxidation of carbohydrate predominates over other aerobic processes in these cells, constituting their major source of metabolic energy. A variety of substances other than carbohydrate may, however, be oxidized by the spermatozoa, and it has been claimed, for example, that acetic acid may be a source of oxidation energy for bull spermatozoa. There is very little catalase present in normal bull semen, which may account for the toxicity of hydrogen peroxide to spermatozoa and possibly also for the harmful effect of pure oxygen on sperm motility. There is still insufficient knowledge to appraise properly the relationships between fertilizing capacity and metabolism of spermatozoa: but much progress in this important biological problem is now being made.

"Mechanism of Fertilisation in Metazoa" is the subject of an extensive and authoritative article by Dr. J. Runnström. This deals with the dependence of fertilizability on the physiological state of the sex cells, and on the interacting substances produced by the germ cells. The structural and metabolic changes following fertilization and artificial parthenogenesis are described in detail. Enzyme activation as a major factor in the incitement of development is discussed. Dr. Runnström has recently emphasized the view that development may be dependent on the activation of enzymes, which are controlled in the cell by inhibitors and activators. There seems little doubt that fertilization and enzyme activity are closely connected. For example, Örström contends that fertilized eggs can form glutamine from added ammonia and glutamic acid, whereas unfertilized eggs are unable to accomplish this synthesis but can break down glutamine to glutamic acid and ammonia. Release of calcium, which may occur on fertilization of the eggs, seems to play a decisive part in enzyme activation.

Fat metabolism receives considerable attention in Vol. 8, in articles on the synthesis of lipides by A. Kleinzeller, on the biochemistry of fatty acid catabolism by F. L. Breusch, and on lipoxidase and the auto-oxidation of unsaturated fatty acids by S. Bergström and R. T. Holman. An article on the present status of the "Antifatty-Liver Factor of the Pancreas" by I. L. Chaikoff and C. Entenman may be included in this group. These articles give a clear over-all picture of the state of knowledge on fat metabolism as seen a year or two ago. Dr. Breusch's article on fatty acid oxidations, written in memory of Franz Knoop who carried out the classical work in this field, is particularly welcome. It represents a detailed account of recent work showing the integration of fatty acid and carbohydrate metabolism. Dr. Breusch's own work in this field is described, and his views are put forward with clarity. He shows how recent work gives rise to the conclusion that the greater part of the catabolism of fatty acids in warm-blooded animals is brought about by a gradual interaction of the muscles and kidneys on one hand, and by the liver on the other. It is accomplished in such a way that liver produces acetoacetic acid and β-hydroxybutyric acid from fatty acids by multiple alternate β-oxidation, by way of two-carbon fragments. These acids are then completely oxidized in the muscles and kidneys by way of the C_6-tricarboxylic cycle. Dr. Kleinzeller summarizes recent work on fat synthesis, describing the conditions necessary for fat formation and the various substances from which fat may arise. He discusses mechanisms of fatty acid synthesis and comments on the work that has been carried out on the synthesis of phospholipides, sterols and waxes. He emphasizes the role of the two-carbon fragment in fat synthesis, a process which is becoming increasingly important as work with isotopic carbon as a tracer progresses. Drs. Bergström and Holman deal with the phenomena of the autoxidation of unsaturated fats, a matter of considerable practical as well as biological importance. The antioxidants, and the possible role of tocopherol in this connexion, are discussed. The new conception in nutrition that fatty livers may arise from a deficiency of labile methyl groups in the diet is the subject of study in an interesting paper by Drs. Chaikoff and Entenman. They go fully into the problem of the interrelationships between choline, methionine and the factors present in the pancreas that affect fat formation in the liver.

Snake venoms are the subject of an article by Dr. E. A. Zeller. He describes the presence in venom of a variety of hydrolytic enzymes, including choline esterase and hyaluronidase, and he points out that *l*-amino-acid oxidase (which differs from the mammalian variety) is the only non-hydrolysing enzyme so far found in snake venoms. Many lesions of brain and nerve are caused by snake venoms, the attack of the neurotoxins being directed towards different parts of the nervous system. There seem to be good reasons for believing that enzyme processes are involved in the action of the neurotoxins; but there is little exact information, and no clear relationships are yet established.

Dr. R. F. Dawson writes a valuable account of the present knowledge of alkaloid biogenesis. He deals with the origin, development and accumulation of alkaloids such as nicotine, *nor*-nicotine, anabasine, hyoscyamine, hyoscine and the cinchona group. Mechanisms of synthesis are discussed, and there is an interesting section on the relations between alkaloid synthesis, protein metabolism and plant physiology.

The dehydropeptidases receive expert treatment at the hands of Dr. J. P. Greenstein. These enzymes act specifically upon peptides containing an α-β double bond adjacent to the substituted amide bond, and are distinct from the peptidases such as dipeptidase, carboxy peptidase, etc., that catalyse the hydrolysis of the peptide bond uniting the normal saturated α-amino-acids. The dehydropeptides promise to be of considerable importance in metabolic processes, and Dr. Greenstein's article is most timely.

Limitations of space alone forbid more than mention of the very valuable articles by Dr. M. Heidelberger and Dr. M. Mayer on quantitative studies on complement; Dr. F. F. Nord and Dr. J. C. Vitucci on the microbiological degradation of cellulose; Dr. H. E. Street on nitrogen metabolism of higher plants; Dr. A. D. McLaren on the effects of light and radiation on enzymes, hormones and viruses; Dr. A. E. Stearn on the kinetics of biological, especially enzymic, reactions; the late Dr. L. Michaelis on reversible step reactions; Dr. D. Glick on the principles of cytochemistry; Dr. T. K. Walker on acid formation in fungal metabolism; Dr. M. A. Joslyn on enzyme activities in refrigerated vegetable tissues; and by Dr. A. Hesse on the industrial biosynthesis of fat. These articles are all of the highest standard, and no research worker in the biochemical or enzymological field can afford to neglect them.

J. H. QUASTEL

GENETICAL THEORIES

The Elements of Genetics

By C. D. Darlington and K. Mather. Pp. 446. (London: George Allen and Unwin, Ltd., 1949.) 25*s*.

IT is with the highest expectations that one opens a book with such a title written by two such authors —Dr. C. D. Darlington, whose creative imagination has done more to advance cytogenetics than that of anyone else alive; and Dr. K. Mather, a recognized master in the discovery and handling of solid facts. The first sentences of the preface, with their promise of speculations to come, only whet the appetite; and enthusiasm may even carry one without a qualm past the second paragraph, with its minatory boast that the doubter "will do well to recollect that this is the first attempt to represent the whole scope of genetics, the whole of what has always been needed".

But when one settles down to read the book, it is not easy to decide what one is expected to look for, or what one can hope to find in it. The first chapter is devoted, as though it were to be a text-book, to the fundamental notions, such as genotype and environment; but the authors choose to demonstrate the importance of the nucleus by quoting Boveri's old experiments in which enucleated sea-urchin eggs were fertilized by sperm of a different species and developed almost purely paternal characteristics; and the unwary student will not discover until Chapter 8, if he retains his critical faculties so long, that this is by no means a general phenomenon, but was used as a debating point to win his untutored consent to a general proposition; in this case, of course, to one which is in the main justifiable. This is, however, only one case out of many in which the authors seem to have failed to take the trouble to produce arguments which are genuinely convincing, either in the light of the known facts or even as questions of simple logic. A similar off-hand manner is shown by the treatment of other authorities. A few references for details of fact are given at the end of each chapter, and the book includes a list, presumably exhaustive, of all genetical books published in English; but these completely unselective citations serve only to conceal the names of those to whom the credit for the development of genetics should really go. What is one to think of a rather full treatment of quantitative inheritance and the theory of natural selection which makes only passing mention of Fisher and none at all of Haldane or of Wright?

One comes to the conclusion that the only logical coherence the book possesses is in the very broad outlines of its arrangement, into parts dealing respectively with individual differences, the genetic determinants of these, and the relations between individuals within populations. One must take it as a series of personal opinions within this loose framework. Its value, then, should not be sought in precision of argument or orderliness of presentation, but in the vividness and novelty of the opinions expressed. We can accept with a smile the rhetoric which leads to the statement that genes "act backwards, as well as forwards, in development" (hastily qualified, one suspects by the other author, by the remark that this is, of course, only a figure of speech), because the phenomena in question actually raise some interesting problems of enzymatic dynamics.

The undaunted reader will be rewarded by much that is stimulating and some suggestions that are likely to point directly to new lines of advance. As might be expected, the most valuable parts of the book are those most closely related to the authors' own fields of work: the discussion of cytogenetics, of breeding systems and the particular mathematical technique for handling quantitative inheritance which has been chosen for exposition. The least valuable, in my opinion—perhaps because it is farthest from the authors' own researches, or because it is nearest to my own—is the section on development, in which almost the whole weight rests on the postulation of plasmagenes; a hypothesis which has the advantage that we know so little about those largely hypothetical entities that we can endow them with properties appropriate to solve all the problems, but with the disadvantage that much of the evidence for their general importance has lost most of its power of conviction since the book was written.

C. H. WADDINGTON

SCIENCE AND THE SEVENTEENTH CENTURY

The Origins of Modern Science, 1300-1800

By Prof. H. Butterfield. Pp. x+217. (London: G. Bell and Sons, Ltd., 1949.) 10*s*. 6*d*. net.

THIS book is of interest and value, not only to the general reader and historian of science, but also to the philosopher, the theologian and the man of letters. The author is professor of modern history in the University of Cambridge and brings a wealth of background knowledge and historical insight to the problem of the origins of modern science. As a result, the seventeenth century is portrayed in its true perspective as the culminating period of the scientific revolution which had its beginnings some two or three centuries earlier.

"The Origins of Modern Science" consists of lectures delivered for the History of Science Committee in Cambridge in the Lent and Easter terms of 1948, now "reproduced in the hope that they may interest the historian in a little science and the scientist in a little history". As indicated in the sub-title, "1300–1800", the period surveyed extends from the fourteenth century, when the Aristotelian explanations of motion were being challenged, to the end of the eighteenth century, when the foundations of the theory of evolution were being laid.

In the first chapter Prof. H. Butterfield directs attention to the historical importance of a theory of impetus—the tradition of the fourteenth-century Parisian school represented by Nicholas of Oresme—whereby a projectile was thought to be carried forward by an actual impetus it had acquired from the mere fact of its being in motion. Later, the works of Copernicus and William Harvey are discussed, and the chapter on experimental work in the seventeenth century has special reference to Galileo. A little farther on there follows a well-balanced account of the history of the modern theory of gravitation. The new habits of mind that emerged had their repercussions on the life and society of the seventeenth century, and in this connexion Prof. Butterfield gives due prominence to Fontenelle's biographical sketches concerning the social successes of the sciences in the reign of Louis XIV. At the end of Chapter 10, which deals with the place of the scientific revolution in the history of Western civilization, the author summarizes his conviction that "what was emerging towards the end of the seventeenth century was a civilisation exhilaratingly new perhaps, but strange as Nineveh and Babylon. That is why, since the rise of Christianity, there is no landmark in history that is worthy to be compared with this." The last two chapters are concerned with the eighteenth-century scientific revolution in chemistry, and with the ideas of progress and evolution which prepared the minds of men for the "Origin of Species" in 1859.

It is a tribute to the author that the presentation of his theme stimulates the reader to more detailed study; the value of "The Origins of Modern Science" is enhanced by a list of suggestions for further reading. H. D. ANTHONY

PEASANT WORK AND WORSHIP IN THE DECCAN

The Aboriginal Tribes of Hyderabad

By Dr. Christoph von Fürer-Haimendorf, in collaboration with Elizabeth von Fürer-Haimendorf. Vol. 3: The Raj Gonds of Adilabad, a Peasant Culture of the Deccan; Book 1: Myth and Ritual. Pp. xvii+450+52 plates. (London: Macmillan and Co., Ltd., 1948.) 35s. net.

AN important gap in our knowledge of the aboriginals of India has been here filled by Dr. C. von Fürer-Haimendorf, for, though Grigson and Elwin have written authoritative accounts of the Gonds of Bastar State, there was previously no comparable work on those of the Central Provinces and Hyderabad. The Gonds, numbering some three million persons, are the largest aboriginal group in India and, as is to be expected, contain many diverse elements and display levels of culture ranging from the most simple to that of the court of a Hindu raja. The author has selected for his subject the primitive and important group inhabiting the Adilabad District between the Godavari and Penganga on the north-eastern border of Hyderabad State. Here more than seventy thousand of them live, preserved, as the author points out, by many years of Moslem rule from the more aggressive elements of Hindu culture. The author and his wife lived among these people for long periods as trusted friends and toured over the whole area. It is their record of what they actually saw, aided by superb photographs, which gives such a fascinating vividness to their account.

The present volume deals with the myth and ritual of the Gonds of the uplands, where the ancient culture is best preserved, and contains also a full account of the Pardhans, who play an essential part as hereditary bards of the Gonds and guardians of their songs and traditions. The tribal myths are no dead relics of the past. They are alive, and without a knowledge of them it would be impossible to understand Gond society; to a Gond the Persa Pen, the 'great god', of his phratry is as real as the founder is to members of an Oxford college. The author was therefore right in recording the full texts of the myths; they are of the utmost value, but it may be suggested that, placed as they are, they tend to interrupt the narrative of the book, so that the ordinary reader would have found it more convenient if they had been relegated to appendixes and their present place taken by condensed and analysed versions.

In course of time the phratries split up into clans and sub-clans, each with its own Persa Pen symbolized by an iron spearhead, a whisk (curiously enough of yak hair), brass bells, a bamboo stave and a cloth, and anthropomorphic idols playing no part in the ritual. Around the simple Persa Pen shrines a most elaborate ritual centres, and the author's first-hand account of the Persa Pen Feast at Marlavai in 1942 is bound to be a *locus classicus* of ethnography.

In the latter part of the book, the annual cycle is described, beginning early in the hot season with a rite corresponding in some ways to the Holi festival of the Hindus, but particularly important for the reason that all who partake of the ritual food affirm the unity of the community by placing themselves under an obligation not to move to another village until after the harvest. At this feast, too, every householder fells a bush or small tree, in memory of the old days of shifting cultivation, and until the ceremonies are over no ploughing may be done. In May, jungle fruit is ceremonially eaten and the ban on its export from the village lifted, and at the same time all the phases of the old agricultural year of shifting cultivation are dramatized with the object of ensuring a good harvest. At this time the great feasts of the clan deities described earlier in the book are celebrated at the full moon, usually preceded by rites in honour of family gods. At one of these, witnessed by the author, a seer in a state of trance was at his own request lashed again and again with whips without showing any sign of pain or bruising. As soon as the rains have really broken, a ceremonial First Sowing takes place, followed by a period of intense activity, for delay in sowing the fields would spell disaster. In June or July another ceremony takes place at which the deities are asked to protect the wandering cattle of their herdsmen, and the ban is lifted on the blowing of horns, the noise of which, it is believed, would have injured the grain when it first began to germinate. In August or September the first fruits are eaten and the harvesting of the small millet begins. The cool season is now at hand and dry weather crops are sown, all of them dating from the time when the Gonds abandoned shifting hill cultivation for plough cultivation in the valleys. Once that work is over, the time arrives for wandering troupes of dancers to entertain the villagers with songs and boisterous pantomimes. It is the time of greatest gaiety for a happy people; but it is not allowed to last long, for the great millet is ripening and has to be protected from birds and marauding deer and harvested in time for a short rest before another strenuous year begins.

It was while serving as adviser to H.E.H. the Nizam's Government for tribes and backward classes that Dr. Haimendorf collected the material for this monograph, and it is good to know that under the present regime he still retains a connexion with the State, and that the measures he proposed for the protection and advancement of the aboriginals are being largely carried out. Many points in Gond culture are obscure, and though an explanation of some of them may be possible when other sections of the tribe are studied, the author is right in leaving a number of questions unanswered for the present. His careful field-work and wide experience have produced a book of the highest value and interest, both to the anthropologist and to the general reader, and the second volume will be eagerly awaited. The publishers have fully maintained their high standard of production, and the price is surprisingly low. J. P. MILLS

England's Dances

Folk-Dancing To-day and Yesterday. By Douglas Kennedy. Pp. 158+16 plates. (London: G. Bell and Sons, Ltd., 1949.) 7*s*. 6*d*. net.

MR. DOUGLAS KENNEDY is the director of the English Folk Dance and Song Society, and as such knows his subject. He has written a delightful little book of some 158 pages with twenty illustrations and two distribution maps. Dancing throughout the ages has been for humanity a psychological release and has been continually used in ritual, both religious and otherwise. Shortly after the first use of mustard gas in the First World War, an American hospital unit took over a complete British tented hospital in Rouen. The strain of the personnel was very great; but it was completely relieved by the introduction of dances. Dancing was the channel for release of the overwrought emotion.

A popular study of English folk-dances and their origin and distribution should be seriously welcomed and should command attention, even from those who are not particularly interested in dancing itself. Following a short introduction by Dr. Vaughan Williams, Mr. Kennedy starts by giving an account of the discovery and revival of a number of ancient folk-dances up and down the countryside. There follows a brief study of the primitive dance and its importance in man's psychological make-up. "The primitive dancer engaged in communicating his vitality by leaps and stamps is himself brought under the spell of rhythm and loses his own self-conscious identity. He becomes, in fact, possessed and ceases to be himself, and the ritual that enwraps him turns him into an actor."

Two seasons of the year were notably connected with special dances—the mid-winter and early spring. The former is associated particularly with the sword dance, the latter with athletic dances performed by young men. "The young men leap and stamp—their rhythmical actions are emphasized by the sound of bells and by the fluttering ribbons. The whole effect, even to the most sceptic observer, is one of tremendous vitality." The connexion between the energy of the world awakening after the winter rest and the energy of the young men is obvious.

It is impossible in a short note to describe in detail this little volume, packed full as it is of factual matter; but I should like to stress, what Mr. Kennedy has well brought out, that the English folk-dances had a meaning—they were, and should still be, the expression of something fundamental to human nature.
M. C. BURKITT

Grundriss der allgemeinen Zoologie

Von Alfred Kühn. Zehnte verbesserte Auflage. Pp. vii+281. (Stuttgart: Georg Thieme, 1949.) 18 D. marks.

THE tenth edition of Dr. A. Kühn's outlines of general zoology has been much altered, both as regards text and illustrations, since the first issue in 1922. It is a bold attempt to give students, especially medical students, some idea of the more general aspects of zoology, in order to stimulate their interest and to stress the importance of special branches of the subject, such as experimental embryology, parasitology and the philosophical conclusions arising from the study of animal life.

A third of the book is devoted to a survey of the animal kingdom, providing the necessary basis for the comparative chapters which follow. Physiology, cell division, maturation, the Mendelian and chromosome theories of heredity, the organisation centre and the development of the animal body are soundly treated. The conditions of animal life in aquatic and aerial media, parasitism and symbiosis are briefly dealt with, and the book ends with a chapter on the species problem, a short and almost wholly German bibliography, and an index. The text is a reliable commentary on modern zoological science. It is surprising to find that the elephant is given 150–200 years of life (p. 247), since all authentic records estimate it at seventy years.

The illustrations are clear and well chosen, especially some of the schematic diagrams and the series of skeletal comparisons. The paper on which they are printed, however, is not very good, and they show through the pages with a peculiar yellowish tinge. Fig. 124*a* is printed upside down. The book can be recommended as a short survey of the various fields of zoology to-day.

A Textbook of Systematic Botany

By Dr. Deane B. Swingle. (McGraw-Hill Publications in the Botanical Sciences.) Third edition. Pp. xv+343. (London: McGraw-Hill Publishing Co., Ltd., 1946.) 30*s*.

ALL those concerned with the teaching and learning of systematic botany in Britain will welcome the appearance of a third edition of Prof. Swingle's well-known text-book, especially as in recent years interest in taxonomy at our universities has considerably increased. "Most of the chapters have been thoroughly revised and amplified, some almost entirely rewritten, and a new one has been added on methods of identification." This revision includes an elementary introduction to the new 'experimental method' in taxonomy and references to literature where further study can be made. The field covered by Prof. Swingle is comprehensive, but it is to be regretted that, even in an avowedly elementary text-book, no room is found for a hint of the difficulties involved in regarding a 'natural' classification as identical with a 'phylogenetic' one. Some warning to students that the subject is not so simple as it seems should surely be given, and some direction as to where the considerable discussions that have taken place on the philosophical background of the problem can be found.
J. S. L. G.

Kinetics of Chemical Change in Solution

By Prof. Edward S. Amis. Pp. ix+332. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1949.) 25*s*. net.

IN the reviewer's opinion this is a very successful book. It presents the basic material in a really adequate way and contains a large amount of information. Special attention is given to the theory of electrolytes and dielectrics. The modern treatment of reaction-rates is fully developed, and cases of real practical importance are chosen for consideration. The mathematical treatment is often full; but in many cases steps are passed over without adequate indication that anything is missing, and the volume contains a surprising number of misprints in the formulæ and equations which may cause trouble to students. The topics include photochemistry and catalysis. The literature references are very full, and adequate attention is given to non-American sources, which puts the book in a class of its own. It can be cordially recommended.
J. R. P.

STATE-AIDED RESEARCH IN FRANCE AND FRENCH SCIENTIFIC INSTRUMENTS

ON February 8, M. Jean de Sailly, Commercial Counsellor to the French Embassy in London, opened at the Science Museum, South Kensington, London, an exhibition of French scientific instruments. M. de Sailly remarked upon the international character of the event, which was made possible only by the closest co-operation between British and French interests. This is the first time in many years that it has been possible for the scientific tools of another country to be examined in detail by a wide scientific public in Great Britain.

Any narrow nationalism in science is to be deplored, but a country which finds it excels in some art or skill may take legitimate pride in it. As Prof. E. N. da C. Andrade observed at the opening ceremony, the French technician exercises his æsthetic judgment in his final designs, which results in an elegance which accords well with the requirements of precision. The exhibition exemplified this principle at many points, and it showed, moreover, how the traditional French genius in optics and mechanics is in no way diminished in the newer fields of electrical technique.

A second aspect of the exhibition was perhaps more significant in the wider view of world science. It is a commonplace that the team has virtually supplanted the individual in much scientific endeavour, and it is further evident that in some branches of scientific study, neither team nor individual can long survive without the patronage of the State or of organised interests of comparable size. It was therefore of more than passing interest to see the exhibition reproduce in miniature the organisation of State-aided research in France. Thus, apart from the contribution of some individual instrument manufacturers, some bearing old and honourable names, there were to be seen main sections from some of the leading French official research agencies.

After the opening ceremony, Sir Ben Lockspeiser presided at the delivery of two addresses on the official organisation of science in France, by Prof. Edmond Bauer, professor of physical chemistry in the University of Paris, and M. Volkringer, head of the Inventions and Patents Department of the Centre National de la Recherche Scientifique. From their surveys one can extract a general picture.

State-aided research in France has a long history, and it has always extended as much to humane studies as to natural science. Indeed, the history can be traced as far back as the foundation of the Collège de France by François I in 1530. There followed the foundation of the Museum of Natural History in 1626, the Observatory in 1667, and the Academy of Sciences in 1666. The Revolution saw the reorganisation of the French universities, and the emergence of the Grandes Ecoles for higher technical education.

The time passed when important research could be done with inexpensive equipment, but no aid was given by the Government until the First World War produced a change in official attitude. At the end of 1915, a Directorate of Inventions was set up for subsidizing war research, a notable outcome being the work of Langevin and Schilowsky, whose system of submarine detection is perpetuated in the ASDIC system.

After 1918, French government support for science again declined until 1930, when a National Scientific Fund was formed through the enlightened collaboration of Jean Perrin and Edouard Herriot, representing respectively the worlds of science and of politics. A period of development and adjustment followed, culminating in 1939 in the fusion of bodies previously devoted separately to pure and to applied research into the Centre National de la Recherche Scientifique. The Second World War and the German occupation failed to destroy the Centre, and it finally achieved its present-day form under Prof. F. Joliot.

The tradition of subsidizing research in humane studies as well as in natural science continues, and a balance is struck between pure and applied research.

The line of historical development has led most directly to the Centre National de la Recherche Scientifique ; but no single agency can represent the whole body of scientific effort. It is natural, therefore, that the past twenty years should have seen the growth of other official research agencies in France, and it is tempting to look for parallels with British practice. The temptation must be resisted, however, since national needs and opportunities have differed too much for any very close resemblance to exist. With the important difference that the Centre National deals with humane studies, we may liken it most closely to the Department of Scientific and Industrial Research in Great Britain, but, as will appear, the analogy is not complete.

The Commissariat à l'Energie Atomique has broadly the same terms of reference as the combined atomic energy divisions of our Ministry of Supply. The Office National d'Etudes et de Recherches Aéronautiques resembles the Royal Aircraft Establishment in its experimental studies and in its link with national defence organisation, but its liaison with the Centre National is closer than that between the two British bodies.

The Centre National d'Etudes des Télécommunications must not be compared too closely with the Telecommunications Research Establishment in Britain, nor the Institut du Pétrole with the Fuel Research Station, but it is sufficient to say that there is much common ground. The Institut National de la Recherche Agronomique and the Institut National d'Hygiène are both young organisations, and have not yet the experience of the Agricultural Research Council and Medical Research Council, but the possibilities of development are clear. Their growth will be watched with interest and sympathy in Great Britain.

Full maturity has been reached only by the Centre National, and it is the chief single influence in the scientific life of France to-day. Although attached to the Ministry of Education, it is financially autonomous. In 1949 its budget was about two and a half million pounds. Its total staff numbered 2,800, of whom about 1,000 had a status equivalent to the 'scientific officer' grades in the British Scientific Civil Service. It has thirty research laboratories, the most important being at Bellevue, with a staff of about 350. It has certain specialized services, such as a breeding centre for experimental animals, a training service for research workers, a documentation service, and an inventions service.

The documentation centre not only publishes its own material, but also subsidizes the publication of books and periodicals. It publishes a *Bulletin Analytique*, an abstracting journal with two unique features. It not only covers all the objective sciences, but has also a section devoted to philosophical studies, and it notifies unpublished matter deposited in the archives of the Centre National.

The Commission des Inventions has some kinship with the National Research Development Corporation in Britain; but may fairly claim at the moment to be in some respects the more advanced. It gives assistance to inventors from the Centre National, or from outside bodies, or to individuals, in all forms from technical advice to financial help in exploitation. Its small budget (some £10,000 last year) limits its scope, but it is dealing with some four hundred inventions annually, and it can initiate special grants, such as that made for the development of the calculating machine of the Institut Blaise Pascal.

Such in outline is the form taken by official research organisations in France; further information can be obtained from the Scientific Office of the French Embassy, 58 Knightsbridge, London, S.W.1.

Organisation does not make research, and the efficacy of the French plan must be judged by results: advances in natural knowledge, advances in material well-being, the overall balance between different fields, and so on. At the least, one may be grateful that the exhibition at the Science Museum has provided an opportunity of judging one other type of result, namely, that of advances in instrumental technique.

Instrument design is subject to fashion, and as new materials and resources become available, style and external appearance change. French fashion would appear now to favour bright colours, open access, easy substitution of alternative components and a much more robust construction all round than we have expected from commercial French instruments in the past.

Design, of course, is partly an individual function, partly a matter of influences, and it is more than amusing to note the differences in style between the different groups. One may certainly detect an American element in the atomic energy exhibits. The subject-matter is irrelevant here. The influence is seen in such details as style of name-plate, shape and size of control knobs and much else which reflects mere habit—a reflexion in turn of the close association which specialists in this field had with British and American activity for so long.

Although outside influences are apparent in the section contributed by the French instrument industry, family tradition, allied with long Continental practice, gives many of the instruments shown an unmistakable character.

These are superficial considerations. The technical accomplishment of French instrument technology is demonstrated by the Fonbrune micromanipulator, the Desvignes monochromator (which uses a single element but is comparable in performance with a double monochromator of conventional design, and has higher luminosity), an excellent recording microphotometer, a compact short-period seismograph, a single-cylinder experimental internal combustion engine for combustion and lubrication studies, and a micro tensile test machine for studying the properties of single fibres. In all these, fitness for purpose is clearly evident, as it is in many of the other instruments displayed. It is this same quality which gives interest to many other instruments for which no claim of originality is made; for example, the analytical mass spectrograph and the multi-unit polarograph shown by the Commissariat à l'Energie Atomique.

The narrow spaces of an exhibition stand focus attention on the laboratory-bench aspect of experimental technique; but one must remember that some investigations necessarily require apparatus of large dimensions. A set of photographs, some striking for the beauty of the photography, showed the Modane high-speed wind-tunnel project of the Office National d'Etudes et de Recherches Aeronautiques. The size of the budget for this enterprise—some millions of pounds—will remind us that the French can match elegance with boldness when the aim is clearly conceived.

The lasting results of this exhibition cannot be assessed yet. Its appeal was not to the large majority looking for handy routine tools, but rather to the few who seek help in seeing science whole. If, as has been suggested, an exhibition of British scientific instruments is held in Paris, the other half of a pattern of joint effort will fall into place. As near neighbours, Great Britain and France have no choice but to collaborate in many spheres. Collaboration and understanding in the sphere of science hold a potential for good which exhibitions of this sort do much to advance towards ultimate realization.

FRANK GREENAWAY

YUKON-ALASKA EXPEDITION OF THE ARCTIC INSTITUTE OF NORTH AMERICA

By PROF. N. E. ODELL

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DURING this past summer (1949) the Arctic Institute of North America (New York branch) organised the second instalment of its programme of field research within the high interior of the St. Elias Range on the international boundary between Yukon Territory and Alaska. The first instalment took place during the field-season of 1948, and a summary of the results attained are given by Walter A. Wood, the leader and organiser, in *Arctic* (1, No. 2; 1948), the journal of the Institute. Referred to as "Project Snow Cornice", the object of this enterprise was glaciological work, as well as geological and meteorological, in a region scantily known and notoriously inaccessible. But the prime motive in the first instance had been programmes of intensive glaciological investigation, such as those which have been conducted in Europe, Greenland and Spitsbergen under Scandinavian, British and Swiss auspices, and which have been lacking so far anywhere in North America.

A high intermontane basin within the St. Elias Range, situated on the Yukon side of the border, and occupied by the Seward Glacier (or firn-field, *sensu stricto*), was chosen as the most suitable locality for these glaciological observations. Such an area of accumulation, approximately 750 square miles in extent, which is the main feeder of the great piedmont Malaspina Glacier, appeared admirable from the point of view of modern glacier-regimen studies. However, such an inaccessible and difficult region, sixty miles at least from the coast, can only in practice be approached or utilized for this purpose by the employment of aircraft. A 'Norseman' aeroplane, fitted with special retractable wheel-ski landing gear, was the answer to the transport problem, and in the hands of the experienced 'bush' pilot, Maurice King, it fulfilled all expectations, even to the extent ultimately of having its possible 'ceiling' improved to an altitude of more than fifteen thousand feet, when in the process of reconnoitring Mt. Vancouver.

From a coastal base at Yakutat, with its airfield of the Civil Aeronautics Authority, the first flight was made in mid June up to the Seward firn-field, where again was established an advanced base for the work of the Expedition. Situated at an altitude of about six thousand feet, nearly fifteen feet of snow had fallen in this locality during the winter of 1948–49, as we were able to determine during the excavation of a cache of stores left in 1948; but precipitation must be heavy at all times in this region. At Yakutat on the coast the average over forty-two years has been 134 inches of rainfall, with a highest annual of 168 inches within that period; while during July 1, 1948–July 1, 1949, as much as 162 inches was recorded.

It was in the vicinity of our 'airstrip' camp on the Seward firn-field that a great part of the glaciological researches was carried out under the direction of Prof. R. P. Sharp, of the California Institute of Technology. These investigations, in continuation of those conducted during the summer of 1948, comprised thermal regimen, firn density and structure, free-water content, melt-water movement, ablation and accumulation. Measures of the thickness of firn and glacier-ice were determined, or attempted, by seismic survey, radar, and gravity meter, but the present technique used, in the case of radar in particular, has so far proved unsatisfactory. Prof. Sharp and his party of five specialists have yet, of course, to analyse fully all their field observations and results. But a promising start has been made with what it is hoped may be a long-term programme of glaciological research to be continued in subsequent seasons on the Seward firn-field as and when circumstances permit.

On the Malaspina Glacier itself, in the vicinity of the coastline, Dr. Henri Bader carried out some crystallographic and structural studies of the stagnant ice of this piedmont mass, and it is anticipated that some interesting results may accrue from these investigations, which it is hoped may be continued in the future. A feature of special interest here is the heavy growth of sitka spruce and western hemlock trees, up to seventy-five feet high and thirty inches in diameter, which has colonized the marginal tract of the Malaspina Glacier. Yet in a convenient exposure it could be seen that the ablation mantle of moraine and debris covering the ice, upon which these large trees were growing, had an average thickness of only 2–3 feet. A number of these trees were cored by a Swedish increment borer, and their ages were found to vary from about fifty years to as much as ninety-nine years in the case of the oldest discovered.

As to the solid-rock geology, with which I was principally concerned, an examination was made of many 'island' outcrops in, as well as the great mountain walls surrounding, the Seward firn-field from our advanced base situated on a nunatak, or rognan, near the foot of Mt. Vancouver. It was sometimes necessary to travel a dozen miles or more on skis over the surface of the vast firn-field to reach particular outcrops, and bad weather and adverse terrain often hampered both topographical and geological mapping. The services of our aeroplane were called upon for visiting the remoter areas to the westward and northward, although conditions of landing on the snowy or icy surface were at times very difficult and required the utmost judgment. In brief, it can be said that the heart of the St. Elias Range consists of a metamorphic series of sedimentary origin, mainly pelitic and calc, and in all probability of Palæozoic and Mesozoic age. Into this series has been intruded an igneous facies which varies from granite to grano diorite and diorite, and it is usually gneissose in structure in the field. A later suite of dolerite dykes cuts the whole complex. The immense mountain masses of Mt. Logan, 19 850 ft. (the highest summit in Canada), Mt. St. Elias, 18,008 ft., and Mt. Vancouver, 15,800 ft., are examples of such acid intrusive occurrence, which by their greater durability, aided possibly by differential uplift, have maintained their pre-eminence. In the case of Mt. Vancouver, of which four of us made an arduous eight days' ascent, and until then the highest unclimbed mountain in North America, it was found that the summit outcrops consisted of a particularly tough arkose or greywacke, much fortified by local aplitic bodies.

It is of interest to recall that as long ago as 1891–92 Prof. I. C. Russell crossed the Malaspina ice-sheet and examined the southern flanks of the St. Elias Range, and in doing so he made the important discovery of Pleistocene (and Pliocene ?) beds having been elevated to some five thousand feet above sea-level. But no one has since followed up his important work. That great elevation has taken place in this region seems to be beyond doubt. Moreover, there is evidence otherwise to suggest that this was, at least in part, probably subsequent to the waning of the much greater Pleistocene glacierization, which appears to have filled the Seward basin to a thickness at least five thousand feet in excess of that of the present day. On the western ridge of Mt. Vancouver I found a moraine-like deposit as high as thirteen thousand feet; but this I am disinclined to regard as firm and unequivocal evidence of the maximum stand of the regional ice-sheet.

Space does not here permit of more than mention of the other interesting discoveries made in the course of the work of the Expedition. The fact that spiders, butterflies, moths, a variety of birds, including even humming-birds, should be found in these remote, frigid and elevated mountain fastnesses, apart from a whole range of alpine and arctic plants, mosses, etc., raises all kinds of questions of migration and indeed origin. Not the least curious discovery, made by me near a camp at about six thousand feet beneath the immense southern wall of Mt. Logan, was that of ice- or glacier-worms, to which occurrence reference has already been made in *Nature* (December 24, 1949, p. 1098). So much mirth and banter has been engendered, even among men of science, by the mention of ice-worms that a peculiar gratification was experienced in this one discovery alone. However, in such a spectacular region there is no need to look for specific thrills, and ice-worms constitute perhaps the least of these.

THE SUTTON HOO SHIP-BURIAL*

By R. L. S. BRUCE-MITFORD

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IN his introduction to the British Museum Provisional Guide (1947), Dr. T. D. Kendrick described this discovery as "the most marvellous find in the archæological annals of England". Subsequent knowledge of the material has shown this to be a just estimate. In outline, the find consisted in the discovery on the east bank of the River Deben, opposite Woodbridge, in Suffolk, buried beneath a tumulus, of a rowing-boat more than 80 ft. long, the central part containing a highly remarkable burial deposit. Of treasure in a strict sense there were regalia and coins of gold and numerous silver vessels; but the many other items in the grave are almost all unique and of the greatest historical value and interest.

The excavation was begun and creditably carried out in the earliest stages under the Ipswich Museum; but the extremely difficult operations of recording and removing grave goods of quite unexpected richness and complexity, in many cases crushed, shattered or decayed, and the great scientific importance which, it was clear, the discovery would have, demanded greater resources, experience and technical skill than were available locally. The excavation was completed by Mr. C. W. Phillips, then a fellow of Selwyn College, Cambridge, and now archæological officer to the Ordnance Survey. Mr. Phillips secured the assistance of some of the ablest figures in British archæology, and of an expert in the history of ship-construction, the late Lieut.-Commander J. K. D. Hutchison, of the Science Museum. It is a most important element in the discovery that it was recorded and observed by skilled professional archæologists, for the last find at all comparable in Britain (and it was a burial of much less importance) occurred in 1883, before the days of modern scientific archæology.

Many of the grave goods deposited in the burial chamber illustrate with a completeness and colour provided by no other find, and equalled among literary sources only in the Beowulf epic, the social life of the Saxon aristocratic hall. The most interesting find in this respect is the small six-stringed maple-wood harp, preserved by the fortunate fact that it had been placed by the burial party in a bronze bowl. It is the first instrument of its kind (a quadrangular harp) to be discovered, a type not hitherto recognized by musicologists, and the earliest reconstructable instrument of post-Roman Europe. There are also the two outsize drinking-horns, with silver-gilt mounts embossed with animal patterns, and fashioned from the horns of the now extinct aurochs. They have a capacity of six quarts. There were five other drinking-horns of normal size (made from ox-horns) and nine tiny vessels with silver-gilt mounts made from the dried skins of scooped-out gourds. The smallest is only 1 in. in diameter and ½ in. high. These must have held something a great deal stronger than the customary mead, beer or wine drunk from larger vessels. The golden treasure and the sword with gold and jewelled mounts, like that borne before Beowulf in Hrothgar's Hall after the slaying of Grendel, and the silver dishes, were also part of the pride and ceremonial of hall-life on occasions of importance. The more strictly domestic appurtenances of the feast are illustrated by three bronze cauldrons, with ornamental wrought-iron gear for suspending them, and three iron-bound wooden buckets.

The forty-five individual items of gold (excluding the coins) constituting the main treasure comprise a ceremonial outfit unparalleled in any other grave. They are fittings of the sword and the baldric on which it was suspended, and of a ceremonial belt. Almost all these pieces are heavily encrusted with garnets. Both technically and in art-historical importance, this jewellery stands higher than any other goldsmith's work of its era that has survived from Germanic Europe. Over and above the perfect assembly, marvellous finish, and sumptuous appearance of all the pieces, is an originality in design, an ingenious inventiveness in technique, a novelty in ornamental themes, and a general feeling that the artist has grown too big for the medium of which he has become past-master, that point clearly forward to the great expansion and flowering of art that distinguishes the latter part of the seventh century in Britain.

The qualities and excellencies of the gold cloisonné jewellery (seen to best advantage in the purse-lid, epaulettes and great buckle, and in the pyramids, scabbard bosses and pommel of the sword) would alone give the Sutton Hoo find European pre-eminence. Other factors, however, raise it on to the European plane more directly; and it is the remarkable constellation in one closely dated grave in a quite specific historical context of a large number of pieces, not only of the highest significance and quality, but also of the greatest diversity, that gives the find its unique archæological status. Thus although the minting of gold coinage had already begun in Kent and London before the date of the Sutton Hoo burial, none of the thirty-seven struck gold coins in the purse was English. They are all Frankish. Of the thirty-seven, seventeen are 'mint-declaring'. If the mints are plotted it will be seen that they fall within, roughly speaking, the boundaries of modern France, and are distributed all over it. The heavy bronze bowl, with drop handles, in which the remains of the harp were found had travelled more than two thousand miles from Egypt. It was almost certainly made in Alexandria. Four stamps on the bottom of a great silver dish, 27½ in. in diameter, show that it had passed through the office of the Imperial assayers in Constantinople during the reign of the Byzantine Emperor Anastasius I (A.D. 491–518). The fifteen other silver pieces in the grave probably came from regions of the Middle East farther afield than Byzantium. The gourd drinking-cups cannot have had any nearer place of origin than the south of France. These pieces show live connexions between seventh-century Saxon England and southern countries and the surviving sub-classical civilization of the Eastern Mediterranean. But the helmet, shield and perhaps sword reveal for the first time in English archæology direct connexions of deeper significance with a different part of Europe—the Baltic coast of Sweden. Three hanging bowls of thin bronze with enamelled ornamental escutcheons came either from Ireland or from the Celtic west of England.

Perhaps the most important single fact about this find is that it can be closely dated. The limits for the burial, between A.D. 650 and 670, deduced from the coins, ranks as excellent dating for any archæological material of this era.

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* Substance of a Friday Evening Discourse at the Royal Institution on October 28.

If, as we have every reason to believe, the Sutton Hoo grave is that of one of the East Anglian kings, this dating margin can be further reduced to the period 654–664, for the three East Anglian kings who died within the larger period (650–670) died in the years 654, 655 and 663 or 664. This precision in dating has a further particular importance in insular archæology in view of the highly complicated art-historical situation in Britain in the middle of the seventh century A.D. At this period we find in progress a creative fusion of Saxon, native Celtic, Irish and Mediterranean elements, and a difference of even a decade either way in the dating of crucial art-documents (such as the Sutton Hoo jewellery) may make all the difference to our interpretation of the course of art development at this time, when British art stood higher than any other in Europe.

The systematic burial of 'grave-furniture' with the dead is a pagan procedure. As the Sutton Hoo burial is the most richly furnished we know, it is in this respect the most whole-heartedly pagan. Yet the burial took place well within Christian times. The general conversion of East Anglia had followed the accession of Sigberht and the establishment by him of a bishopric at Dunwich. These events occurred not later than A.D. 631. Indeed, the grave itself contains clear signs of Christianity, not only in imported objects such as the set of ten shallow cross-bearing silver bowls and the pair of silver spoons bearing in Greek the names Saul and Paul, but also in the locally made jewellery, and, significantly, on the most personal and cherished object in the grave, the dead man's sword. The design of the gold and garnet scabbard-bosses is based upon an equal-armed cross of specifically Christian character. We must also note that these Christian pieces do not occur haphazardly in the grave, but were placed, as with deliberation, at the right side and shoulder of a recumbent body, visualized as lying in the position indicated for the body by the disposition of the grave-goods. If we take this to mean that the dead man was a Christian, and if we still regard him as one of the East Anglian kings (as, among other things, two symbols of office, the giant whetstone and iron standard indicate), serious difficulties arise. It is not so much that the provision of grave goods was a pagan custom, for the Church did not prohibit the practice; but from the first the Church sought to ensure that Christian bodies were buried in consecrated ground, and particularly was this the case with royal families. It would be almost impossible to imagine Anna (one of the three eligible East Anglian kings, who died in 654), a most Christian person, all of whose daughters became nuns and three of them saints, as being buried in the old pagan grave-field at Sutton, when there were numerous churches and monasteries in Suffolk to receive his body. In fact, we know that he was buried at Blythburgh, and that his body was still venerated there in the twelfth century. It is similarly difficult to imagine that the body of another of the three eligibles, Aethelwald (died 663–4), lay here. He was a Christian, godfather to the king of Essex, and died in the year of the Synod of Whitby. It is possible that (if the burial does not represent an unrecorded lapse into paganism) the solution to the dilemma lies in the absence of the body. No trace of any body, even in the form of stains, bone meal or changes in the colour or texture of the soil, could be found by the excavators where it should have lain. An analysis of the positions in which the gold jewellery was found shows that this 'regalia' cannot have been worn on a corpse, either sitting or lying. Other important factors point strongly to the conclusion that the grave never contained a body; but was a cenotaph. If this is so, it is possible that in the great ship-burial we have the public and traditional monument of a king, whose body received Christian burial elsewhere. The Sutton Hoo burial falls just at the close of an heroic age, and in a strange phase of transition between paganism and Christianity. It may be that we have in it another monument typical of this phase, like the Franks casket, with its mixture of pagan and Christian iconography, or the Beowulf epic, in which Christian sentiments and references suffuse older pagan material.

The Sutton Hoo ship-burial is the first intact royal inhumation of its period to have come to light in Europe since the burial of Childeric I, King of the Franks, was discovered at Tournai in 1653. Great importance is thus attached to the application to it of the full range of modern scientific technique and of modern scholarship. In the first place, we have the field technique of the excavators, which enables us, for example, to make an accurate scale model of the Sutton Hoo ship—the earliest English naval vessel—although its timbers had wholly perished, leaving no more than stains and iron rivets in the sand; and which records every phase of the excavations, in addition to plans and notes, in more than a thousand photographic negatives of high excellence. Upon the excavated and recorded materials is brought to bear the resources and experience of the British Museum Research Laboratory, supplemented by a wide range of specialist scientific knowledge and experience from outside the Museum, in botany, zoology, ornithology, geology, human anatomy, metallurgy and other fields. Finally, the material is subjected to the full apparatus of modern historical scholarship based upon the widely ranging researches of many workers in literary, historical and archæological fields. Thus not only is the Sutton Hoo find in itself richer than any other European grave of its era that has come down to us; but we are also able to extract from it vastly more information than has been possible from any strictly comparable European find of its kind in the past.

An illustration of these points is provided by the reconstruction of the Sutton Hoo harp. Its basis is the careful recovery by the excavators of some hundreds of fragments of crushed and distorted wood belonging to the instrument. By re-building and re-assembling two tenon-and-mortice joints in pieces of the main framework, and fitting to it two gilt-bronze plaques with projecting birds' heads, from which ran rivets which held fast the joints, it was possible to re-assemble the framework of the instrument up to a certain point, though without its sound-box or resonator. The result indicated a six-stringed instrument some eighteen inches in height. The wood of the frame was identified as maple in the Department of Botany at the British Museum (Natural History). The stumps of six pegs which came from the peg-holes in the curved arm of the instrument were identified as either poplar or willow by the Director of the Jodrell Laboratory in the Royal Botanic Gardens at Kew. At various points on the maple frame were inconspicuous dark patches. They consisted of hairs and skin, and microscopic examination at the British Leather Manufacturers' Research Association showed that they were from a fur-bearing animal. Later on, Dr. J. L. Stoves demonstrated that they were beaver hairs. From the distribution of hairs on the frame it was possible to deduce that the harp had been kept in a beaver-skin bag. Inquiry into the stringed instruments of the ancient world showed that they fall into two classes, lyres and harps. The lyres are invariably symmetrically designed about the peg-arm or yoke at the upper end of the instrument, whereas harps are asymmetrically designed about the upper-end or peg-arm. The Sutton Hoo remains belonged to an instrument asymmetrically designed in this respect and therefore to the harp class. In the harp, however, the longest limb is itself a broad hollow box which functions as the resonator of the instrument. In the Sutton Hoo instrument this limb is thin and solid. The instrument must have had a resonator to function at all, and the only solution that the surviving remains allowed was that it had been of quadrangular form with the resonator at the bottom. Notes made when the remains were excavated showed that this portion of the instrument would have projected at the top of the bronze bowls in which the remains were found, and a large number of fragments of thin maple sheeting taken from the top of the bowls proved to be the remains of a capacious sound-box. For the solution of many remaining problems of detail, a practical approach was necessary. Musicologists were consulted, and experimental models were made in the workshops of Messrs. Arnold Dolmetsch, Ltd., at Haslemere. An experimental playing reconstruction, attained through study of the remains and experiment, was confirmed by research among early illustrations. An eleventh-century Anglo-Saxon MS. in St. John's College, Cambridge, for example, showed in use an instrument of the same kind as the Sutton Hoo harp. The fact that it is held by a second person, and that the player is touching the strings from both sides, showed that it is an open-stringed instrument of harp-type, with a resonator at the bottom, and not a vertically held frame (psaltery) with sounding-board behind the strings. There is no direct evidence for a tuning key among the Sutton Hoo remains; but the use of such a device was inferred from the fact (only ascertainable by experiment) that even when the heads of the pegs were made of the smallest size that would allow the fingers to get a purchase on them, the spacing of the peg-holes was so close that, when two adjacent peg-heads came nearly horizontal, it was impossible to pass the fingers between them. Justification for this inference was later found on the ivory cover of a twelfth-century manuscript in the British Museum, on which a musician may be seen tuning an instrument of the Sutton Hoo type with a small key.

The harp as reconstructed has a charming tone, and wide melodic range, and simple harmonies can also be performed on it. To ears accustomed to brass bands and the ninety-piece orchestra it sounds surprisingly soft; but this softness is a true characteristic of primitive stringed instruments, and is to be found, for example, in the shoulder-harps of ancient Egypt or the recent clavichord.

The Swedish connexion in the Sutton Hoo find provides a good example of its European implications. The common custom of boat-burial, confined at this period to Suffolk and Uppland, and certain material from Sutton Hoo, show that we are not dealing with casual gifts or imports, but with a deeper connexion. It is too early to interpret this connexion with authority; but it has been suggested that the East Anglian royal house (the Uffingas) may prove to be in origin a branch of the royal house of Uppsala. This connexion is an entirely new fact in English history, to which documentary sources give no clue. The intimate character of the archæological links may be indicated by the fact that one of the scenes on the Sutton Hoo helmet was only reconstructed with the aid of an identical scene on a helmet newly excavated in Sweden, and that gold cloisonné pyramids like those that decorated the sword-knot of the Sutton Hoo sword have so far been found elsewhere only in the great royal mounds at Old Uppsala.

Years of study and digestion lie ahead before the full significance of the Sutton Hoo discovery will be understood. What we already know of it well illustrates the great potential historical value of archæological material, even within the framework of comparatively recent history. A monument such as this, both in general interpretation and the wealth of concrete detail it provides, brings the modern student in many ways into living touch with seventh-century life and history, where other documents do not exist, remain tantalizingly silent, or singularly fail.

NEWS and VIEWS

Prof. J. E. Littlewood, F.R.S.

Prof. J. E. Littlewood, the first holder of the Rouse Ball chair of mathematics at Cambridge, will vacate it this year on reaching the age of sixty-five. A pupil of F. S. Macaulay at St. Paul's School, he learned as a boy to distinguish between vital ideas and examination tricks. Going to Cambridge, he realized that preparation for the tripos would consist largely of acquiring a repertoire of tricks, but decided that it was a game that he could play as well as his contemporaries, and he was bracketed senior wrangler in 1905. He lost no further time before plunging into real mathematics, and he proved some deep results about integral functions. He spent three years at Manchester and returned in 1910 to a fellowship and lectureship at Trinity College, Cambridge; he was elected professor in 1928. After the triumph of the Abel–Tauber theorem (1910) he began his long partnership with Hardy, a partnership without parallel in the history of mathematics. Among the topics to which they made major contributions in the course of thirty years are convergence and summability of series, trigonometrical series, inequalities and the analytic theory of numbers.

Littlewood has done much work independently, mainly in complex-function theory, and he has collaborated on a large scale with Paley, Offord and Miss Cartwright. A mathematician of the front rank normally produces, apart from his finest theorems, work which a reader feels has not really stretched him. In the pages which Littlewood has written, running into thousands, there are remarkably few which could have been the work of anyone else. He has distilled the essence of years of lectures into two highly individual books, "Elements of the Theory of Real Functions" (1926) and "Lectures on the Theory of Functions" (1944). During the First and Second World Wars, he solved a number of mathematical problems directed to what he called trivial purposes. In the former of these two periods he was a second-lieutenant in the Royal Artillery; but it may be assumed that he avoided the menial tasks which usually fall to subalterns.

Littlewood is a legendary rather than a public figure; when he has travelled abroad, it has been for athletic interests and not to talk mathematics. But he has started many young men in research. They get from him no gifts of easy problems, but boundless encouragement to try the hard ones: "If you don't solve *that* problem, it will lead you on to another one". Elected to the Royal Society at the age of thirty, he received a Royal Medal in 1929 and the Sylvester Medal in 1943. In making the latter award, the President of the Royal Society said: "He was the man most likely to storm and smash a really deep and formidable problem: there was no one else who could command such a combination of insight, technique and power".

Mathematics at Cambridge:

Mr. A. S. Besicovitch, F.R.S.

MR. A. S. BESICOVITCH, who succeeds Prof. Littlewood, began research in Russia under the famous Markoff. He left Russia in 1925, and with a Rockefeller studentship worked in Copenhagen and Oxford for two years. After a year as lecturer at the University of Liverpool, he was appointed to a lectureship at Cambridge; he has been a fellow and lecturer of Trinity College since 1930. He was elected to the Royal Society in 1934. Besicovitch is a 'real variable analyst'. His work is normally as austere as it is distinguished, and by temperament he avoids the limelight, but dramatic surprises pursue him. He has recently exploded a long-accepted theory of the area of a surface. This is a highly technical matter; but two other surprises are intelligible to the layman. In 1927 there was the following unsolved problem: Find a figure of least area within which a segment of unit length can turn through 360° in continuous movement. Everyone accepted the common-sense solution of a 3-cusped hypocycloid of area $\frac{1}{8}\pi$. Besicovitch's solution, however, is that the figure can have arbitrarily small area ε; it grows infinitely complicated as $\varepsilon \to 0$ and spreads towards infinity in all directions (*Math. Z.*, 27, 312). The second example is actually a re-discovery (*J. London Math. Soc.*, 22, 285) of a forgotten result by Tietze of 1905; but it is a perfect foil to the first: What is the maximum number of convex polyhedra, non-overlapping, and any pair having contact over a positive area? (The corresponding number in two dimensions is 4.) Having annihilated an area the first time, Besicovitch has now done the opposite; for this answer is infinity.

T. G. Masaryk (1850–1937)

MARCH 7 is the centenary of the birth of Thomas Garrigue Masaryk. Born of humble parents at Hodonin in Moravia, he served as an apprentice first to a Vienna locksmith and then to a country blacksmith before a local schoolmaster arranged for his entry into the secondary school at Brno, the Moravian capital, in 1865. In 1872 he matriculated at the University of Vienna and studied philosophy, graduating as Ph.D. in 1876. After an anxious period as a lecturer in Vienna, Masaryk was appointed professor of philosophy at Prague when the University was re-organised in 1882. From that time until 1914 Masaryk wrote and lectured on philosophical subjects with the object of promoting Czech culture, especially as regards modern trends. He founded the daily *Cas* ('The Times') and himself conducted its weekly science column. From time to time he became involved in philosophical disputes and in political controversies and was thrice elected to the Austrian parliament. In 1918 he was elected first president of the Czechoslovak Republic, and with Beneš, his son Jan Masaryk, and others, achieved a good measure of success, especially in culture and technology, in both of which Masaryk himself was keenly interested. The University of Brno, founded in 1919, bears his name, and so does the Masaryk Academy of Work, which sponsored many scientific and engineering projects. It seemed as if Czech science and learning, with sound traditions rooted in the past, was at last attaining the success it deserved, when the State was first dismembered and then occupied by the Germans in 1939. Masaryk's spirit, his insistence upon the force of the Hussite motto, "Truth Prevails", and his influence still remain to inspire the nation afresh in its struggles against adversity.

Geological Society: Foreign Members

The following have been elected foreign members of the Geological Society: Prof. J. Cadisch, professor of geology, University of Berne; Prof. C. O. Dunbar, professor of palæontology and stratigraphy, Yale University; Prof. R. F. Flint, professor of geology, Yale University; Dr. P. A. Geijer, director of the Geological Survey of Sweden; Prof. M. Gignoux, professor of geology and mineralogy, University of Grenoble; Prof. L. C. Graton, professor of geology, Harvard University; Prof. A. Heintz, professor of palæontology, University of Oslo; Prof. R. Richter, professor of geology and palæontology, University of Frankfurt; Prof. A. S. Romer, professor of zoology, Harvard University; Prof. L. Störmer, professor at the Palæontological Institute, Oslo; Prof. T. Vogt, rector of the Norges Tekniske Högskole, Trondheim.

Journal of the Optical Society of America

BEGINNING with the January 1950 issue, Dr. Wallace R. Brode, associate director of the United States National Bureau of Standards, succeeds Prof. G. R. Harrison as editor of the *Journal of the Optical Society of America*. Dr. Brode has been for several years a director of the Society and an associate editor of the *Journal*. In an editorial to the December 1949 issue of the *Journal* (39, 979), Prof. Harrison pays tribute to his successor and remarks on the rapid growth, both in size and numbers printed, of the *Journal* during the past decade. The number of subscribers, now 3,700, has almost trebled; and the increase in size of the *Journal* is illustrated by the fact that when Prof. Harrison took over the editorship ten years ago it was his ambition to average sixty-four pages per issue; but now his successor will have to tackle the pressing problem of the limitation of each issue to the ninety-six much larger pages allowed for in the 1950 budget of the Society.

Science for Farmers

CRITICISMS have recently been made that little progress is being made in the teaching of science in adult education classes despite a widespread interest in current science among members of the general public. These criticisms are well founded and it is refreshing to read of places where attempts are being made to show how science can be taught to adults in the local community. The luncheon room of the Fox Inn in Worcestershire is such a place, and here, under the auspices of the Extra-Mural Department of the University of Birmingham, Gilbert Cope has recently completed a series of lectures on biological topics to a representative cross-section of the local male population (*Further Education*, **3**, No. 2; September–November 1949). Since the lectures were held at the normal place of evening congregation little could be attempted in the way of demonstration, but the use of topical films added to the interest of the course. To arouse enthusiasm, this course had been preceded by a trial run of four lectures on soils and plant physiology which had been succeeded by another course on more practical aspects of farming like breeding and rearing, feeding, milking, calf rearing, and management of young stock. The real value of further education of this kind is that it brings the results of scientific research to the people who can effectively employ them, and so unites academic achievement with practical labour.

Weekly Records of Earthquake Epicentres

THE epicentre cards sent out by the United States Coast and Geodetic Survey, Washington, D.C., and prepared by the Survey in co-operation with Science Service and the Jesuit Seismological Association, have long been a boon to seismological observatories. These observatories are now more deeply indebted to the Survey, under its director, Rear-Admiral L. O. Colbert, for a new series of weekly cards, the first of which was issued on June 30, 1949, giving a tabulation of minor earthquakes. The range of epicentres is world-wide, and for each earthquake the initial time is given together with the preliminary determination of epicentre (latitude and longitude) if observations warrant this—otherwise the epicentral area is named. The first earthquake mentioned occurred on June 12, and the weekly numbers listed have been 7, 5, 8, 7, 21, 9, 8, 11, 5, 27, 7 and 7 so far. Although the new lists are probably not entirely comprehensive, chiefly owing to lack of a complete world-wide network of observatories and also difficulties of communication, they do give an idea of the seismic activity in the world when coupled with the details of major earthquakes on the epicentre cards (old series) which have been issued by the same office for so long.

Blundell's School Science Society

Two articles in the magazine of Blundell's School Science Society show the high standard of work which can be obtained from schoolboys who are encouraged to do original work. In one, O. F. Amor describes some observations made on the effect of acidity on the distribution of *Gammarus pulex* in a moorland stream. Although the investigations could not be conducted on a scale to justify firm conclusions, the evidence obtained indicates that *G. pulex* does not tolerate a pH lower than 6·5. It is probable that this freshwater shrimp cannot exist long in water of this acidity, but that a neutral or slightly alkaline medium of pH 7–7·5 is favourable. In the other article, D. C. R. Stephens discusses the competition between weeds and grasses from investigations made in various school lawns. His observations confirm the theoretical requirements for a successful weed in a lawn, namely, rapid germination, growth and development, rapid reproduction and effective means of evading the mower. The magazine also contains an account of a study of the blue-tit as well as records made by the ornithological, meteorological and other sections.

Frank B. Jewett Fellowships: New Awards

THE American Telephone and Telegraph Co. has awarded Frank B. Jewett fellowships to the following: Dr. J. B. French, a graduate in physics and mathematics of Dalhousie University, Nova Scotia, and the Massachusetts Institute of Technology, for research at the Institute for Advanced Study, Princeton, on higher-order radiative processes in the quantum theory of fields; Dr. Ilse L. Novak, a graduate in mathematics of Hunter College and Radcliffe College, for research at the University of California on relation algebras; Mr. R. F. Steiner, a graduate in chemistry of Princeton University and at present a graduate student at Harvard University, for research at the University of California on light scattering of the actin-myosin system, and its relation to the phenomena of muscular contraction; Dr. D. E. Mann, a graduate in chemistry and physics of the City College of New York and the University of Chicago, for research in quantum mechanics at Harvard University (Dr. Mann held a Jewett fellowship last year); Dr. Roy J. Glauber, a graduate in physics of Harvard University and at present an Atomic Energy Commission postdoctorate fellow at the Institute for Advanced Study, Princeton, for research at the Institute on the theory of elementary particles. Grants for the fellowships were established in 1944 by the American Telephone and Telegraph Co. upon the retirement of the late Dr. Jewett as vice-president in charge of development and research, and since that time thirty-three awards have been made. The fellowships are designed to stimulate and assist research in the fundamental physical sciences by men of science who have recently received or are due to receive doctorates. The awards are made on the recommendation of a committee of seven from the Bell Telephone Laboratories; they carry a grant of 3,000 dollars to the recipient and 1,500 dollars to the institution at which the research is done.

Colonial Service: Recent Appointments

THE following appointments in the Colonial Service have been recently announced: E. Bellis (agricultural officer, Kenya), soil chemist, Kenya; C. W. S. Hartley (agricultural officer, Federation of Malaya), senior agricultural officer (research), Federation of Malaya; M. Greenwood (principal agricultural officer, Nigeria), assistant director of agriculture (experiments), Nigeria; H. J. S. Simpson (agricultural officer, Federation of Malaya), senior agricultural officer, Federation of Malaya; O. J. Voelcker (director, West African Cocoa Research Institute, Gold Coast), director of agriculture, Federation of Malaya; J. West (principal research officer, West African Cocoa Research Institute, Gold Coast), director, West African Cocoa Research Institute, Gold Coast; L. G. T. Wigg (senior assistant conservator of forests, Tanganyika), deputy conservator of forests, Tanganyika; G. M. Stockley (chief geologist, Tanganyika), director of geological survey, Tanganyika; J. G. Black (veterinary surgeon, British Guiana), veterinary officer, Northern Rhodesia; D. Sheriff (veterinary officer, Northern Rhodesia), veterinary officer, Kenya; W. Uruski (veterinary officer, British Guiana), senior veterinary officer, British Guiana; A. E. Billington, canning officer, Federation of Malaya; J. Duncan, agricultural officer, Kenya; G. C. Gamey, agricultural officer, Nigeria; J. D. A. Harris, agricultural officer, Sierra Leone; C. B. Mead, agricultural officer, British Solomon Islands Protectorate; R. M. Scott, soil survey officer, Agricultural Department, Gold Coast; R. G. Tapley, entomologist, Tanganyika; M. S. Foulstone and C. A. N. Nash, assistant conservators of forests, Nigeria; L. R. Allen, geologist, Federation of Malaya; K. G. Gadd, pathologist, Northern Rhodesia; J. F. F. Callear, veterinary officer, British Guiana; M. B. Proverbs, veterinary officer, Barbados; P. W. Thorold and M. L. Burdin, veterinary research officers, Kenya; S. C. Abel and T. A. Dillon, agricultural survey officers, Gold Coast; K. H. Bain, fisheries officer, Gold Coast; A. D. H. Berwick, biologist, Game and Tsetse Control Department, Northern Rhodesia; C. R. Harler, tea research officer, Nyasaland; H. R. Mapother, insecticide chemist, West African Cocoa Research Institute, Gold Coast; R. G. Mares, veterinary officer, Somaliland Protectorate; D. Small, assistant conservator of forests, Sierra Leone; D. R. Wilson, statistician, Statistical Department, East African High Commission; L. F. U. Wix, government chemist, Medical Department, Gold Coast.

University of London: Appointments

The following appointments in the University of London have been announced: Dr. J. E. Smith, lecturer in zoology in the University of Cambridge, to the University chair of zoology tenable at Queen Mary College from October 1, 1950; Dr. D. D. Reid to the University readership in epidemiology and vital statistics tenable at the London School of Hygiene and Tropical Medicine from January 1, 1950.

The title of professor of agricultural chemistry in the University has been conferred on Dr. R. L. Wain in respect of the post held by him at Wye College; and that of reader in bacteriology in the University on Dr. S. E. Jacobs in respect of the post held by him at the Imperial College of Science and Technology.

The title of emeritus professor in the University has been conferred on the following: Prof. E. N. da C. Andrade, Quain professor of physics at University College during 1928–49; Prof. C. S. Gibson, professor of chemistry at Guy's Hospital Medical School since 1921; Prof. Hamilton Hartridge, professor of physiology at St. Bartholomew's Hospital Medical College during 1927–47; and Sir Ian Heilbron, professor of organic chemistry at the Imperial College of Science and Technology during 1938–49.

The following doctorates have been conferred: *D.Sc.:* Mr. H. H. Hatt (external student); Mr. G. E. Turfitt (external student); *D.Sc.* (*Eng.*)*:* Prof. C. A. Hart (University College).

International Exhibition of Wild Life Photography

The second International Exhibition of Wild Life Photography, organised by *Country Life*, will be held at the Central Hall, Westminster, London, during March 20–April 1, excluding Sunday. More than four thousand entries have been received from sixteen countries as well as from British photographers. Of these, about 1,400 subjects have been chosen for exhibition by the Selection Committee. These photographs are divided into sections of mammals, birds, insects, fish and amphibians. In addition, there is a section devoted to colour transparencies. An important addition to the Exhibition will be lectures illustrated by films or slides twice daily. The Nature films will undoubtedly be the finest ever shown at one exhibition and the majority are in colour. The Exhibition will be opened by Field-Marshal Viscount Alanbrooke on the afternoon of March 20.

International Congress of Mathematicians

The first international Mathematical Congress to be held since 1936 will take place at Cambridge, Massachusetts, during August 30–September 6, under the sponsorship of the American Mathematical Society. A grant of ten thousand dollars has been made by the United Nations Educational, Scientific and Cultural Organisation to be used for travelling expenses of foreign mathematicians attending the Congress. A conference, which it is hoped will lead to the formation of an International Mathematical Union, will be held just before the Congress, and for this Unesco has made a similar additional grant of ten thousand dollars.

Announcements

Prof. R. A. Peters, Whitley professor of biochemistry in the University of Oxford, has been awarded the Cameron Prize in practical therapeutics for 1950, given by the University of Edinburgh, in recognition of his discovery of British anti-lewisite (B.A.L.) and the application of this drug in practical therapeutics.

A Ramsay Memorial fellowship is being offered for chemical research. The fellowship is worth £400 a year, with a grant for research expenses not exceeding £100 per annum, and is normally tenable for two years. Further particulars can be obtained from the Joint Honorary Secretaries, Ramsay Memorial Fellowships Trust, University College, Gower Street, London, W.C.1, to whom applications must be forwarded not later than April 17.

The Chemical-Biological Coordination Center of the National Research Council will hold a two-day symposium on chemical-biological correlation in Washington, D.C., during May 26–27. The meeting will include papers on the relation of the structure of compounds to their biological activities, discussions, and a session illustrating the operations of the Center and the services it can provide to scientific workers. It is expected that a symposium volume will be prepared and published after the meeting. Those interested in attending should register as soon as possible with the Symposium Committee, Chemical-Biological Coordination Center, National Research Council, 2101 Constitution Ave., N.W. Washington 25, D.C.

Under the terms of a reciprocal arrangement with the Centre National de la Recherche Scientifique, the Medical Research Council is offering two scholarships in medical science, excluding clinical medicine, which are tenable at research institutions in France during the academic year 1950–51. Candidates must be of British nationality and have at least a working knowledge of French. The scholarships are worth 30,000–60,000 francs a month, according to qualifications and experience, plus travelling expenses and a supplementary marriage allowance. Application forms can be obtained from the Secretary, Medical Research Council, 38 Old Queen Street, London, S.W.1, and must be returned by March 31.

ISOLATION OF A CRYSTALLINE TOXIC FACTOR FROM AGENIZED WHEAT FLOUR

By Dr. P. N. CAMPBELL, Dr. T. S. WORK and
Sir EDWARD MELLANBY, G.B.E., K.C.B., F.R.S.

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IN 1946 it was established by Mellanby[1] that dogs fed a diet rich in commercially 'improved' (nitrogen trichloride-treated) flour were subject to epileptiform fits; similar fits were never seen in control animals fed on untreated flour. Mellanby concluded that the treatment of flour with nitrogen trichloride gave rise to a toxic factor which was responsible for the condition in dogs well known in Great Britain as 'canine hysteria' and in the United States as 'running fits'.

A large proportion of the flour milled in Britain and used for bread-making is 'improved' by treatment with nitrogen trichloride and is known commercially as 'agenized' flour. The observation that this flour was toxic to dogs was followed by a demonstration that it was also toxic to ferrets[2], to cats[3], and to rabbits[4]. It thus became a matter of some importance to discover the nature of the toxic factor and to assess the possible danger which might arise from the use of agenized flour.

Method of Test

Throughout the present investigation the criterion of toxicity adopted has been the production of a typical epileptiform fit in the ferret. The ferret is slightly less sensitive than the dog on a body-weight basis; but the small size of the animal enabled us to obtain a toxic reaction with a much smaller dose of agenized flour than would be necessary for a dog.

The demonstration by Mellanby[2] that toxicity was confined to the gluten fraction of the flour suggested that the toxic factor might be a modified amino-acid or peptide. The final method of isolation which is outlined below was based on this assumption.

Isolation of Crystalline Toxic Factor

Flour was agenized by the standard procedure but with ten times the amount of nitrogen trichloride used in commercial practice (11·1 gm. NCl_3 to 17·7 kgm. flour). This flour was toxic to a ferret in a dose of 100 gm. (1·9 gm. nitrogen) fed over three days. Gluten was separated from the flour and digested first with pepsin and then with trypsin. The digest was dialysed and the dialysate hydrolysed for four hours with strong hydrochloric acid. The acid was removed and the hydrolysate electrodialysed. The neutral fraction from the electrodialysis was treated with sufficient charcoal to remove the aromatic amino-acids[5], and the residual neutral amino-acid mixture was then fractionated on a 'Zeokarb 215' column by the method of Partridge[6]. A fraction was obtained from the 'Zeokarb' column which produced a typical fit in a ferret when fed for three days at a level of 17 mgm. nitrogen per day. This active material contained at least fifteen components and was further fractionated by chromatography on a paper column ('Solka Floc') using a mixture of butanol, acetic acid and water as solvent. The toxic factor crystallized when the appropriate fraction of the effluent was concentrated.

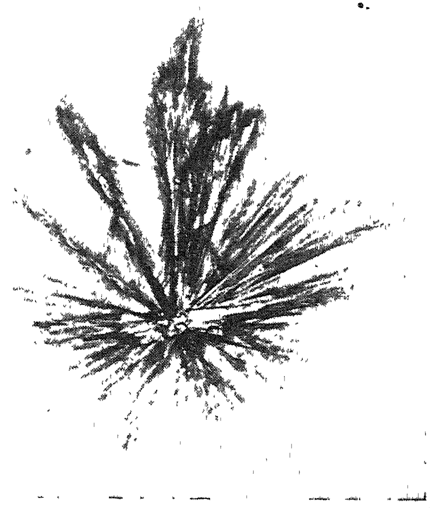
Toxicity

The crystalline toxic factor (see accompanying illustration) produced severe epileptiform fits in a ferret when fed for five days at a level of 100 μgm. nitrogen per day; this represents a total dose of crystalline material of approximately 3 mgm. The pure toxic factor is thus 33,000 times as toxic as the original flour.

When fed as a single dose the crystalline material is slightly more toxic than when the dose is spread over several days. A single dose of 2 mgm. is sufficient to produce typical epileptiform fits in a ferret, and a slightly greater dose kills the animal. Particular emphasis must be laid, however, on the cumulative nature of the poisonous effect. We have demonstrated in the ferret that a fatal toxic reaction can be produced by feeding the concentrated toxic factor in small doses over a period of five to ten days, and that the daily intake in such cases is only a fraction of the dose required to produce an immediate toxic response. It must be added, however, that this toxic action is not a simple problem and is probably influenced by other elements in the diet.

Nature of the Toxic Factor

As the amount of toxic factor in flour is small (1 gm. per 33,000 gm. flour) and the isolation procedure gives an overall yield of only 10 per cent, the greatest difficulty has been experienced in obtaining sufficient material for combined biological



Crystalline toxic factor from agenized flour (× 180, phase contrast) and chemical characterization. All the results reported below have been obtained on about 10 mgm. of crystalline toxic factor.

We were initially of the opinion that the toxic factor was a peptide, since a sample hydrolysed for twenty-four hours with $6N$ HCl at 110° and examined by partition chromatography[7] in two dimensions on paper was found to give six ninhydrin-positive spots. One of these spots was, however, identified as the toxic factor itself, and even forty-eight hours hydrolysis did not destroy it entirely. As a peptide could scarcely be expected to resist such vigorous hydrolytic conditions some doubt arose in our minds as to the peptide nature of our material.

A specimen of toxic factor hydrolysed for 24 hr. with $6N$ hydrochloric acid was studied in detail and the following degradation products were provisionally identified by paper chromatography: homocysteic acid, α-aminobutyric acid, methionine sulphoxide, methionine sulphone and homoserine. Since all these compounds can be regarded as possible degradation products of a molecule containing the methionine skeleton, we concluded that our toxic factor was probably derived from methionine. A small sample of the crystalline material was desulphurized by treatment with Raney nickel[8], and the product identified by paper chromatography as α-aminobutyric acid; methionine gave α-aminobutyric acid under similar conditions.

It might be thought from the above evidence that the toxic factor was produced from methionine by a simple reaction with nitrogen trichloride. However, this would not appear to be so, for Silver[9] has shown that when methionine is treated with nitrogen trichloride the toxic factor is not produced. We have recently treated the following peptides (kindly supplied by Dr. Fruton) with nitrogen trichloride: methionyl-glycine, carbobenzoxymethionyl-methionine amide and carbobenzoxymethionyl-methionine, and were unable to detect the presence of the toxic factor by partition chromatography after either a 4- or 16-hr. hydrolysis with strong hydrochloric acid at 110° C.

Comparison of Toxic Factors from Wheat Flour and Zein

Dr. Reiner, of Wallace Tiernan and Co., has recently kindly supplied us with a sample of a crystalline toxic factor which had been isolated from zein treated with nitrogen trichloride. Our crystalline material was indistinguishable from that of Dr. Reiner when examined by two-dimension partition chromatography on paper. The melting points of the two materials were within the same range, and both materials, fed to ferrets, produced the same toxic reaction.

While this work was in progress three communications[10] appeared from the laboratory of the British Flour-Millers Research Association, St. Albans, on a toxic factor present in nitrogen trichloride-treated zein. Although we have not been able to carry out a direct comparison between our own material and that isolated by this group, we find that the published details on the properties of the crystalline material isolated at St. Albans are in close agreement with our own. It seems highly probable, therefore, that the material isolated by us from agenized flour is identical with the material isolated by Dr. Reiner and independently by the St. Albans group from nitrogen trichloride-treated zein.

We are indebted to Mr. J. Smiles for the photograph of the crystalline toxic factor and to Dr. C. Dent for samples of homoserine and α-aminobutyric acid.

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DIRECT OPTICAL MEASUREMENT OF THE LENGTH OF ORGANIC MOLECULES

By Dr. J. S. COURTNEY-PRATT

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STUDIES are being made in this Laboratory of the nature and structure of the surfaces of solids and of films adsorbed on them. Adaptation of the optical techniques developed by Tolansky[1-6] makes it possible to examine detail with a resolution approaching 1 Angström. Direct measurements have now been made of the thickness of monomolecular layers of adsorbed organic materials.

If a collimated beam of monochromatic light of wave-length λ falls on a pair of partially reflecting surfaces separated by a small thickness t of material of refraction index μ, interference fringes will in general be visible either in reflexion or transmission. Maxima of intensity in transmission, that is, for Fizeau fringes, will occur where $2\mu t \cos \varphi = n\lambda$; n is an integer, φ is the angular departure from normal incidence measured in the medium between the surfaces. For low coefficients of reflexion, the variation of intensity from one fringe to the next follows approximately a cosine^2 curve. For high coefficients of reflexion the variation of intensity follows closely the Airy distribution[7]. Tolansky has shown that the width of these sharpened Fizeau fringes can be twenty times less than for two-beam interference. That is, the width of the fringes at half their maximum intensity can be as small as 2 or 3 per cent of the spacing of the fringes, and also the maximum rate of change of intensity with change of thickness can be ten or twenty times greater than for two-beam interference, provided that the physical conditions are made suitable. In particular, the reflexion coefficient must be made high—preferably greater than 90 per cent, and the absorption kept low so that there is a significant transmission coefficient. It is critical that the spacing t should be kept small. The incident light should be carefully collimated; and the wedge angle between the surfaces should be small.

To attain optimum resolution and to satisfy these and other minor experimental conditions, a thin piece of muscovite mica was chosen as a reference material. For such a material, where the upper and lower reflecting surfaces are almost exactly parallel, the

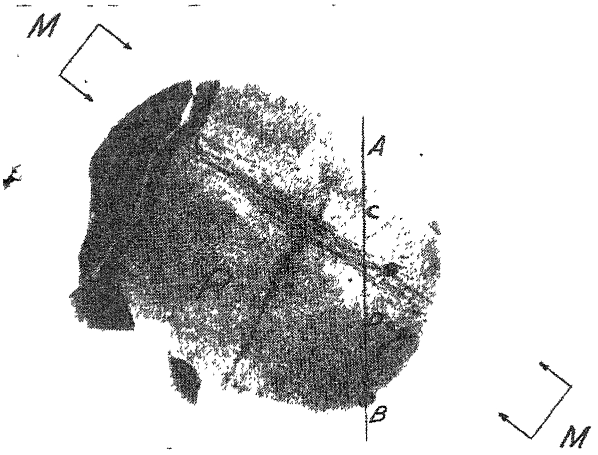

Fig. 1. Photograph, at 3 ×, of a piece of mica showing clearly the region *MM* on which a monomolecular layer of stearic acid had been spread. After adding the monomolecular layer, both sides of the specimen were silvered. Illumination was provided by a collimated beam of monochromatic light of wave-length 5461 A. The specimen was tilted 4° from normal incidence, so that the transmitted intensity for facet *P* was approximately half the maximum. Small sustained changes in thickness were then evident as considerable changes in intensity. The fine scratches within the area *MM* were made while spreading the stearic acid. The ghost fringes most visible at the top right are due to reflexions from the microscope slide supporting the specimen

spacing between successive fringes is indefinitely large. Any facet of constant optical thickness will transmit a monochromatic radiation with uniform intensity[4-6]. If the wave-length is so chosen with respect to the average optical thickness and the angle φ that the transmitted intensity is half the maximum, then minute changes of thickness will be evident as considerable changes of transmitted intensity. With typical values of reflexion coefficients attained in practice, a change in thickness of 10 A. can produce a change of intensity of between 15 and 25 per cent.

Fig. 1 is a photograph of a piece of muscovite mica at three times natural size. The facet *P* is of uniform thickness to a single lattice spacing over its whole extent. On part of one side of this facet a monomolecular layer of stearic acid ($C_{17}H_{35}COOH$) has been spread by a modification of the droplet-retraction technique. Silver has then been evaporated *in vacuo* on to both sides of the specimen until the reflexion coefficients are greater than 90 per cent. A collimated beam of monochromatic light from a low-pressure mercury-arc lamp was used to illuminate the specimen, which was then tilted 4° from the normal so that the transmitted intensity for facet *P* was approximately half the maximum obtainable. The region *MM* over which the monomolecular layer had been spread is plainly visible in the photograph.

The uniformity and extent of an adsorbed monomolecular layer can be examined qualitatively as described above. An unambiguous quantitative measure of thickness can be made using the same specimen. Illuminate it at normal incidence with a collimated beam of white light, and use the transmitted light to form an image of the specimen at the plane of the slit of a spectrograph. It is now possible to determine what wave-lengths are most strongly transmitted for all points of the image that fall on the spectrograph slit; that is, for all points on any chosen line section of the specimen.

The interference fringes that appear at the plate of the spectrograph have been called fringes of equal chromatic order[3,6]. The wave-lengths of maximum intensity satisfy the same equation as before. $2\mu t \cos \varphi = n\lambda$; and also the variation of intensity from one fringe to the next again follows the Airy distribution. Maximum fringe sharpening depends in almost the same way on the experimental variants.

Fig. 2 shows the fringes of equal chromatic order for the line section *AB* of Fig. 1. The fringes are all doublets because of the birefringence of mica. The displacement $\delta\lambda$ of the section *CD* corresponding to the region over which the monomolecular layer of stearic acid had been spread is $2{\cdot}0 \pm 0{\cdot}3$ A., so that the measured thickness of the monomolecular layer is $n\delta\lambda/2\mu = 19 \pm 3$ A. From X-ray studies, the length of the *c*-axis of stearic acid in crystalline form is 48·84 A. The unit cell is formed of two molecules attached by their acid end-groups. Electron diffraction studies indicate that on reactive or on noble metals, fatty acid molecules in the first adsorbed layer are arranged with the acid end-groups adjacent to the solid surface and with the hydrocarbon chains standing at right angles to the surface. If the molecules are similarly oriented when adsorbed on mica, the expected thickness of the monomolecular layer would be half the length of the *c*-axis, that is, 24·42 A.

Fig. 3*a* is a photograph of the fringes of equal chromatic order for a different specimen of mica showing two facets, *Q* and *R*. Fig. 3*b* is similarly a line section across the same specimen but crossing a region of facet *Q* on which had been spread a monomolecular layer of octacosanoic acid ($C_{27}H_{55}COOH$). The measured thickness of the monomolecular layer is $30 \pm 1\frac{1}{2}$ A. The value of half the length of the *c*-axis from X-ray data is 37·02 A.

The discrepancy between the measured values and those obtained by X-ray methods is not a random experimental error, but is most probably due to the differences in the phase change on reflexion at the mica – silver surfaces and the monolayer – silver surfaces and possibly also on transmission at the monolayer – mica surfaces. These phase changes would be indistinguishable from real thickness effects. For adsorbed layers of both stearic acid and octacosanoic acid the phase changes at the monolayer – silver interfaces should be equal, as the inert end-groups of the straight-chain molecules are identical; and similarly any phase changes at the monolayer – mica surfaces for both these acids should be equal as they adsorb to the mica by similar acid end-groups. This hypothesis is confirmed, within the limits of experimental measurement, as the difference in the measured lengths of the fatty acid molecules (30 A. – 19 A. = 11 A.) is closely the same as the difference obtained from X-ray observations (37·02 A. – 24·42 A. = 12·6 A.).

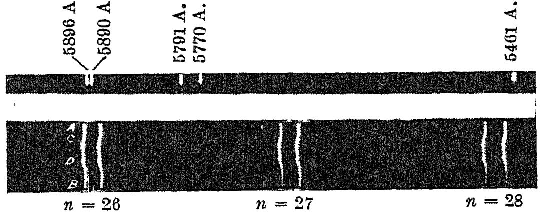

Fig. 2. Fringes of equal chromatic order for the line section *AB* of Fig. 1. The wave-length of the line *AB* is 5899 A. The displacement to *CD* is $2{\cdot}0 \pm 0{\cdot}3$ A., so that the measured thickness of the monomolecular layer of stearic acid is $n\delta\lambda/2\mu = 19 \pm 3$ A. The dispersion near the *D* lines is 3·5 A./mm. The magnification of lateral dimensions in the direction parallel to the slit is 2 ×. Displacements in wave-length are linearly related to changes in thickness of the specimen, so that in this photograph the magnification in height and depth is 315,000 ×. (Reproduced two-fifths original size)

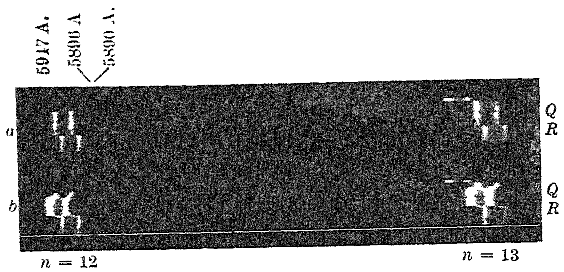

Fig. 3. Fringes of equal chromatic order for two facets Q and R of a specimen of mica

(a) Fringes for a line section across the facets where no monomolecular layer had been spread

(b) Fringes showing a displacement of 7·4 ± 0·3 A. on that part of facet Q on which a monomolecular layer of octacosanoic acid had been spread. The measured thickness of this layer is then $n\delta\lambda/2\mu = 30 \pm 1\frac{1}{2}$ A. The dispersion near the D lines is 3·5 A./mm.

The magnification of lateral dimensions is 2·3 × ; the magnification in height and depth is 720,000 ×. (Reproduced two-fifths original size)

By traversing the specimens across the line of the spectrograph slit, it has been possible to examine methodically the whole of the areas over which the organic materials had been spread. Near the lateral boundary of a layer there is a decrease in its apparent thickness. Away from the boundary the layer is uniform. Polymolecular layers are absent. The method therefore provides direct and independent evidence that the molecules of fatty acids spread by the retraction technique are adsorbed on the surface as a uniform monomolecular layer.

I wish to express my thanks to Dr. F. P. Bowden for his encouragement and advice, to Imperial Chemical Industries, Ltd., for the provision of the spectrograph, to the Ministry of Supply (Air) for support and to the Royal Commissioners for the Exhibition of 1851 for the award of a Senior Studentship.

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CHANGES IN FIBRE-LENGTH WITHIN ONE GROWTH RING OF CERTAIN ANGIOSPERMS

By I. J. W. BISSET, Dr. H. E. DADSWELL and G. L. AMOS

Division of Forest Products, Commonwealth Scientific and Industrial Research Organisation, Melbourne

THE general pattern of variation in tracheid and fibre dimensions within a tree is well known. Sanio[1], many years ago, established that at a fixed level in *Pinus sylvestris* L. there is a gradual increase in mean tracheid length from the initial ring outwards until a more or less constant length has been reached, and, further, that there is a variation with height in the tree. Other workers[2] have confirmed these findings with various species of Gymnosperms and Angiosperms. However, evidence regarding the variation within one growth ring is contradictory in the case of Gymnosperms and, so far as we know, lacking for Angiosperms.

Recently, in an investigation of this point in *Eucalyptus gigantea* Hook. f., a eucalypt of south-eastern Australia growing at altitudes of 3–4,000 ft., it was found that late wood fibres were approximately 60 per cent longer than early wood fibres of the same growth ring, and that the fibre-length variation followed a characteristic pattern through the various growth rings (see Fig. 1). Similar variations were observed in other eucalypts which also have the distinct growth rings indicative of temperate conditions, namely, *E. regnans* F. v. M., *E. dalrympleana* Maiden, and *E. pauciflora* Sieb.; but in those eucalypts without such definite growth rings, as, for example, *E. deglupta* Blume from New Guinea, there were no significant fibre-length variations in the wood laid down over several years. In the case of *E. gigantea* the fibre-length variation has been directly correlated with growth-rate[3]. It has been shown that the shortest fibres from the first-formed early wood of a growth ring are coincident with the maximum growth of early spring, and the longest fibres from the last-formed late wood with the minimum growth of early winter; the increased fibre-length of the late wood is accommodated by a greater overlap of the fibres.

Following these observations, a preliminary survey has been made of fibre-length variation within one growth zone of various Angiosperm timbers. Results obtained are given in the accompanying table. In those species with definite growth rings, the late wood fibres were considerably longer than the early wood fibres and, in some of the ring-porous species, they were two to three times as long. Generally, the fibre-length pattern within the growth ring followed that shown for *E. gigantea* (Fig. 1); but in certain species the increase in length was rapid, and a more or less constant value was quickly reached (for example, *Tectona grandis* Linn. f., see Fig. 2). Chalk and Chattaway[4] have reported that the vessel members of the early wood of ring-porous woods are consistently of greater diameter and shorter than the vessel members of the late wood. This is in agreement with our observations on fibres, and supports the conclusion that there must be a close relationship between cell dimensions and growing conditions, because growth in such species is at a maximum in the early part of the growing season. The species from tropical regions showing indistinct growth zones showed little variation in fibre-length in the wood laid down during several years growth.

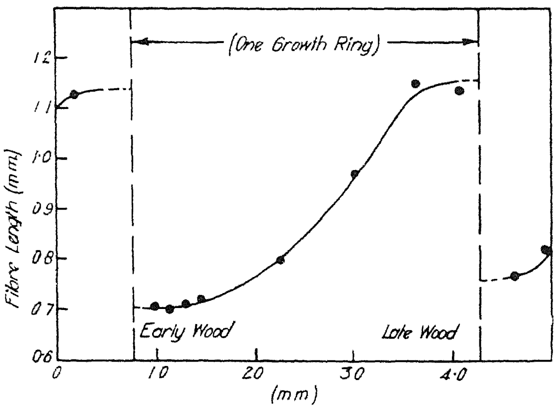

Fig. 1 Fibre-length variation in one growth ring of *Eucalyptus gigantea* Hook. f.

FIBRE-LENGTH VARIATIONS BETWEEN EARLY WOOD AND LATE WOOD OF THE ONE GROWTH RING IN SELECTED ANGIOSPERMS

Species	Mean fibre-length of First formed early wood (mm.)	Mean fibre-length of Last formed late wood (mm.)	Percentage difference based on early wood length
A. Eucalypts with distinct growth rings			
E. gigantea Hook f.	0·71	1·15	62
E. regnans F. v. M.	0·81	1·19	47
E. dalrympleana Maiden	0·97	1·28	32
E. pauciflora Sieb.	0·70	1·00	43
B. Ring-porous timbers and diffuse porous timbers with distinct growth rings			
Castanea sativa Mill.	0·62	1·35	118
Quercus robur L.	0·71	1·33	87
Fraxinus excelsior L.	0·51	1·46	186
Ulmus campestris L.	0·72	1·54	114
Cedrela toona Roxb. var *australis* C.DC.	0·75	1·37	83
Tectona grandis Linn. f.	0·93	1·34	44
Fagus sylvatica L.	1·18	1·44	22
Populus tremuloides Michx.	0·83	1·28	54
C. Species without distinct growth rings			
Castanea javanica Blume*	1·17	1·27	8·5
E. deglupta Blume *E. grandis* (Hill.) Maiden *Lithocarpus perclusa* Mgf	No significant variation over several growth zones		

* Some indication of growth rings

In view of the results obtained, it is appropriate to discuss briefly the variation of tracheid-length within one growth ring of various Gymnosperms. Gerry[5] reported that in *Pseudotsuga taxifolia* (Lamb.) Britt. the late wood tracheids were shorter than those of the early wood. Lee and Smith[6], working with the same species, obtained contrary results; their observations are supported by those of Kribs[7] (with *Pinus banksiana* Lam.) and Chalk[8] (with *Picea sitchensis* (Bong.) Carr.), both of whom state that the tracheids of the late wood are slightly longer (12 per cent in *P. sitchensis*) than those of the early wood. Recently, Wardrop[9] referred to the decrease in the tracheid-length of *Pinus radiata* D. Don from the early wood to the late wood of the one growth ring. We have examined a number of Gymnosperms, including those mentioned above, and have found that, in all cases where compression wood is not present, the late wood tracheids are slightly longer (up to 11 per cent) than the early wood tracheids, thus confirming the observations of Kribs and Chalk. It would seem, therefore, that the variation within a growth ring follows the same general trend in both Angiosperms and Gymnosperms in which distinct growth rings are present, although the variation in length from early wood to late wood is much less marked in the Gymnosperms.

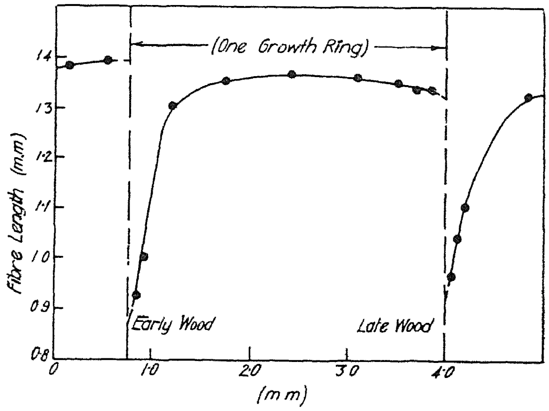

Fig. 2. Fibre-length variation in one growth ring of *Tectona grandis* Linn. f.

In all the investigations reported here, fibres (or tracheids) were obtained by the maceration of serial tangential sections (80 or 120 μ thick) cut through one or more growth rings of the timber under examination. Fifty fibres from each section were selected at random for measurement. The differences in mean fibre-length as given in the table have been shown by statistical analysis to be highly significant.

This work, which will be reported in detail elsewhere, forms part of the programme of the Division of Forest Products, Commonwealth Scientific and Industrial Research Organisation, Australia.

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NATIONAL RESEARCH COUNCIL OF CANADA

ANNUAL REPORT

THE thirty-second annual report of the National Research Council of Canada* contains the report of the president, Dr. C. J. Mackenzie, and the financial statement for the year ended March 31, 1949, and provides a general conspectus of the work which is now described in fuller detail in the "National Research Council Review". Progress with atomic energy has continued, and the Isotope Branch has distributed thirty-four different isotopes to twenty-one institutions for experimental work in pure and applied science. The Chemical Engineering Research Branch has been enlarged to investigate new plant-processes for separating and purifying the products, and the Technical Physics Branch has notably improved the design and reliability of electronic engineering devices and microchemical equipment. In the Division of Applied Biology some further fundamental work was undertaken in the study of the fermentative breakdown of cellulose, the installation of electrophoresis and diffusion-rate equipment for the study of proteins and carbohydrates, studies on halophilic bacteria, and the physiology of muscle in rigor. Work on the Fritz continuous butter-making machine continued, as well as pilot-plant investigations on the fermentation of beet molasses and the processing of gluten from wheat flour.

The Division of Building Research, which started work during the year, has concentrated its attention on questions of building practice in relation to house construction. In the Pure Chemistry Branch photochemical and other kinetic investigations have been made on ether, acetone, acetaldehyde, ethylene oxide and a number of hydrocarbons. Radioactive carbon is being used for labelling particular functional groups to follow their course in photochemical reactions. The compressibility of pure helium in the temperature range 0–600° C. has been determined with a high degree of accuracy. Work has continued on the infra-red spectra of complex organic compounds, especially those of biological importance, and on plant alkaloids, particularly on the chemical constitution of those alkaloids previously discovered in the laboratory; the investigation of the acid-dyeing of wool has also continued.

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* Thirty-second Annual Report of the National Research Council of Canada, 1948–49. (N.R.C. No. 1961.) Pp. 35. (Ottawa: National Research Council, 1949.)

Besides its advisory functions to other government departments on the supply or testing of chemicals, the Applied Chemistry Branch is investigating the use of the fluidized bed technique for the recovery of oil from Athabaska tar sands, the mechanism of detergency and of the inhibition of corrosion by silicates and chromates, the high-temperature corrosion of heat-resistant alloys, the evaluation of anti-freeze materials as regards the corrosion of the cooling system of internal combustion engines, and the occurrence, purification and chemistry of natural and synthetic unsaturated fatty acids. Problems relating to the use of a Canadian-produced synthetic rubber have been investigated in collaboration with the Polymer Corporation, and work on the catalytic oxidation of ethylene to ethylene oxide has been directed towards acquiring the engineering data for the design of a pilot plant. Some work has been done in extension of Reppe's work on the synthesis of acetylene derivatives. Investigations in the Division of Mechanical Engineering have included further work on the control and stability of tailless aircraft and on the model of the Fraser River, and problems in connexion with the use of fuels and lubricants at low temperatures. The design and construction of special instruments required in the laboratories is a responsibility of the instrument laboratory.

The Division of Physics made plans for a spectroscopy group in July 1948, and the building up of equipment for precision electrical standards and work continued on the thermostatic control of refrigerator cars as well as on the colorimetry of railway fusees. Investigations were initiated on the possibilities of a camera mount with very soft restraints for minimizing the effect of pitch, yaw and roll on image movement in air photography and on the factors affecting the resolving power in a print made by a projection. The Division of Radio and Electrical Engineering was occupied mainly in fundamental research in radar and radiophysics and application of radar techniques to peace-time problems, including the development of two electrostatic generators of the Van de Graaff type and a study of methods of applying Shoran radar techniques in measuring the distance between two fixed points on the ground with sufficient accuracy for geodetic purposes and in determining the position of an aircraft engaged in taking photographs at intervals along a flight line.

The research programme of the Division of Medical Research is entirely extra-mural, and 118 projects were supported during the year, including fundamental research on such subjects as the physiology and biochemistry of muscular activity, cellular development, growth, destruction and regeneration; the physiology and biochemistry of nervous and special-sense activity; mechanisms of secretion; metabolic studies, including the role of vitamins; and studies on blood constituents, including the cells, enzymes, lipids and clotting agents. Thirty medical fellowships were held at seven universities during the year; the Council also granted 169 scholarships for postgraduate work, and 148 were actually held as against 145 in the previous year, mainly in physics (51), physical chemistry (29), chemistry (14) and organic chemistry (13). The work of the Technical Information Service also substantially increased, and the section now handles about four hundred inquiries a month. Pending the development of a national library in Canada, the library of the Council endeavours to provide some of the services which the science branch of such a national library might give.

RESIDENTIAL COURSES FOR SUPERVISORS

AMONG the subjects discussed at the British Institute of Management Conference at Margate in 1949 was whether there is a need for short residential courses to be provided on a national scale for foremen and supervisors. The subject was introduced by Major W. F. Scott, director of training to Tube Investments, Ltd., who stated that during the past thirty years the number of people employed in large businesses has greatly increased, processes of production have become much more scientific, and autocratic management has either yielded place to democratic or is fighting a hopeless rearguard action. Industry rests to-day upon the willingness of the operative to perform his task, and the supervisor is the propeller shaft linking the motive power of management with the operative. The link, therefore, should be fit for its important function, and this implies good initial selection and training of supervisors followed by some method of ensuring that he is kept up to date on all developments, technical, administrative and psychological, which affect his daily life.

Under the old order, the foreman's principal tool of control was the power of dismissal, but the stress and strains of war and the need for higher production under the conditions of the Essential Work's Order laid bare the weaknesses in this system. In most factories it was necessary to introduce one ancillary department after another, and each of them removed from the foreman's authority some function which had previously been his unchallenged prerogative. In the pressure of events, little was done to make him understand why changes were necessary.

Efforts to solve the difficulty were made by many technical colleges, which arranged special courses for foremen during the evenings; but their total impact on the problem was small. The Training Within Industry Scheme which was introduced from the United States also proved a useful help to the supervisor; but it did little to re-orientate him to the changed environment of an industrial world of full employment and a more complicated administrative structure. Supervisors' societies have also grown in number, and the Institute of Industrial Supervisors has come into being for the express purpose of helping its members to a better understanding of their jobs.

It is significant, however, that several large industrial organisations have come to the conclusion that something more is needed and have instituted internal courses for their supervisors. A few of these courses are residential in character, and with these, Major Scott suggested, the advantages accruing from residence outweighed the added cost involved. But there are few concerns in Great Britain which are big enough to be able to organise their own courses and, if there is need for additional training facilities beyond those provided by technical colleges, the need must be met by industry combining to provide the instruction required under the conditions which will make it most effective. Residential training is essential owing to the short time that supervisors can be away from their jobs and because it ensures that every waking hour of that absence will play its part in making the training effective.

During the discussion most speakers agreed that such residential establishments could play a useful part in national recovery, although Mr. R. R. Hopkins, of Vauxhall Motors, Ltd., believed that the number of men who would benefit from fortnightly courses would be so small that it might be better to arrange for a much bigger number of foremen to attend courses of shorter duration. Dr. I. Blain, of the National Institute of Industrial Psychology, described experiences which had been obtained during an investigation which some members of the Institute's staff have been carrying out during the last few months. Foremen who have already attended such courses as these proposed by Major Scott believe that the real value of the courses comes from personal contacts rather than from the content of the course. Supervisors find it difficult to understand the general principles which it is feasible to teach them in a course of a rather academic type, and they do not know how to apply these general principles to the specific practice which holds in their organisations. Such courses, therefore, should be supplementary only to the training processes which should go on continuously within the individual companies. Mr. N. C. Rimmer, of the British Institute of Management, brought out the important point that the number of people attending each course should be limited and also that the atmosphere provided should be conducive to development of the co-operative spirit.

A plenary session of the Conference agreed that residential courses for foremen training should be set up throughout the country and that the British Institute of Management should use its efforts to further the study of the problem, to stimulate the provision of facilities in all suitable establishments, to co-ordinate and assist endeavours, to promote further experiments, and to encourage the full use by industry of the opportunities so provided.

T. H. Hawkins

M.K.S. SYSTEM OF ELECTRICAL UNITS

It is now some forty-nine years since Prof. Giorgi first put forward his proposal for the establishment of a system of units based on the electrotechnical practical units together with the metre, the kilogram and the second as an alternative to the centimetre–gram–second electrostatic and electromagnetic systems. This system of Prof. Giorgi, now commonly known as the M.K.S. System, was accepted by the International Electrotechnical Commission in 1935, and in 1948 the absolute volt and absolute ampere were introduced internationally as a result of a decision of the Comité International des Poids et Mesures taken in 1946.

It might be thought that a matter upon which these international decisions had been taken after searching examination over so long a period would be one in which there could be little room for further discussion, and that by this time the M.K.S. System would have taken its place in the general practice of electrical engineering. "Future practice," wrote Giorgi in his memorandum of 1934 for the International Electrotechnical Commission, "will show which units are the most convenient for every particular purpose and the law of the 'survival of the fittest' will receive application." The fact is, however, that the adoption of the M.K.S. System has proceeded relatively slowly.

In two publications recently reprinted from Philips Research Reports, "The Rationalised Giorgi System and its Consequences" by P. Cornelius and H. C. Hamaker, and "Proposals and Recommendations Concerning the Definitions and Units of Electromagnetic Quantities" by P. Cornelius, the essential features of the M.K.S. System are re-stated, the position of the system reviewed and specific recommendations are made regarding it. It is particularly interesting that these two papers originate from an industrial organisation, as one of the reasons sometimes adduced for the slow progress in the adoption of M.K.S. units is that the main advantages of the system lie rather in the academic sphere and that the practising engineer or scientific worker is not as a rule greatly concerned about the matter. The first-mentioned paper gives an excellent account of the basis of the system and deals in some detail with the various controversial issues which have emerged in connexion with it, notably that of the E—H and E—B analogies. The case for rationalization, which is not, of course, specific to the M.K.S. System but has become inextricably linked with it, is cogently argued.

University and technical college teachers of pure or applied science will find much of interest in these communications. The ultimate benefit to the science and practice of electrical engineering of teaching students on the basis of a single unitary system can scarcely be called in question, and the problem of how best to incorporate M.K.S. units into the general structure of electrical engineering courses has become an urgent matter. It may be noted, in this connexion, that on March 30 a symposium of papers on the M.K.S. System of units will be presented to the Institution of Electrical Engineers.

James Greig

ENERGY OF THE STARS

The Halley Lecture for 1949 was delivered at Oxford on May 12 by Dr. R. d'E. Atkinson, who chose "The Energy of the Stars" for his subject (*The Observatory*, 69, 851 ; October 1949) ; as its scope is very comprehensive, it is quite impossible to give more than a mere outline of the points dealt with.

In the Lecture a short historical sketch is given of the problem of stellar energy from the days when it was thought that radioactivity provided a solution, up to recent times. This deals with the work of Eddington, Gamow, Houtermans, Russell and many others, including that of Atkinson himself, who has devoted a considerable amount of time to the subject during the past twenty years. Present nuclear theories are unsatisfactory in certain respects, and among the difficulties confronting them may be mentioned that of the energy development of the diffuse giants which stand off the main sequence in such a manner that their energy source cannot easily be reconciled with that of other stars. Explanations have been attempted, but are not entirely satisfactory; and it is suggested that a solution may ultimately be found connected with an important factor—the true distribution of the stars in space.

It is well known that the bright main-sequence stars lie close to the plane of the galaxy, while the diffuse red giants are scattered much more uniformly, and also that the former are conspicuously absent from globular clusters. Some five years ago, Baade found that certain nearby galaxies show similar characteristics, and it is suggested that rotation may be connected with these factors. Many bright stars are rotating rapidly and also revolving with high speed round the centre of the galaxy—unlike the red giants and the globular clusters—and rotation may have an important influence on energy generation. It seems possible that a star which has very little axial rotation could condense in its central regions to an extent that would be difficult if it were rotating rapidly. Although it is probable that such a dense core would involve a temperature sufficiently high for the Bethe cycle to operate, it seems unlikely that the Bethe cycle would lead to stars of this nature as well as to main-sequence stars. Even if the core were sufficiently dense for its gravitational energy to suffice for a long-term energy supply, it is admitted that a very high density would be required.

One serious problem that seems almost intractable is the inadequacy of the 0·008 mass-excess of the hydrogen atom to keep a bright star shining for a long period even on the assumption that it started as practically pure hydrogen and is now nearly pure helium. No star which is 125 times as bright as the sun, and which fits the mass-luminosity relation, can live at this rate as long as the sun has lived, assuming that synthesis is its only source of energy; and it is difficult to account for those stars which have 100,000 times the luminosity of the sun and only 100 times its mass. Either such stars must be very young—a most improbable supposition—or they have become bright in recent times; but even then they would have very little hydrogen left.

Towards the end of the Lecture, reference is made to the work of Bondi and Gold (*Mon. Not. Roy. Astro. Soc.*, 108, 262; 1948) which suggests the continuous generation of matter out of nothing. Assuming that such matter is hydrogen, it would assist in explaining stellar energy provided it could be collected by the stars; but it is very improbable that this could be done with sufficient rapidity. In addition, the hydrogen accretions should penetrate the deep interiors of the stars, and it is difficult to see how this can be done, because the heat produced by impact would stop the motion downwards. Another point which arises is the retardation of rotation by the collection of diffuse extraneous matter; but, as already pointed out, the bright stars are rotating rapidly. One way of surmounting the difficulty—although the General Theory of Relativity does not suggest it—is to restrict this spontaneous generation of matter to places where there is a large amount of matter—the interiors of massive stars. If, however, the diffuse giants are to be included in this scheme, it may be necessary to postulate that the process cannot occur in non-rotating stars.

One tentative suggestion is made. If a very massive star continued to increase more and more, the final result would be that things would get out of control and an explosion would occur which would not result in a mere supernova but in a new expanding universe. The star would disintegrate into portions, each of which would become a new galaxy, and as new supplies of uranium and other radioactive elements would be produced at the same time, the universe resulting from the explosion might show signs of having started at a definite date. It is admitted, however, that the concentration of the generation of matter in the interiors of stars must be regarded as a mere *ad hoc* speculation.

ASTRONOMY AND NAVIGATION

A PAPER by D. H. Sadler on "Astronomy and Navigation" in a recent number of *Occasional Notes of the Royal Astronomical Society* (13, 2; September 1949) will be very useful to all who are interested in astronomy as applied to navigation. Part 1 of the paper gives a short historical sketch of the subject and then provides an account of the relationship between the Royal Astronomical Society and navigation. This part will be of special interest to fellows of the Society, many of whom are probably unaware of the important part that the Society has played in the design of the "Nautical Almanac" and also in the contributions of a few of the fellows to nautical astronomy. Although the number of papers is small, they are very useful, and some of them must be regarded as highly valuable contributions to the subject.

Part 2 deals with modern developments—including radar—which raise the question, "Why the need for further development in astronomical navigation ?". The answer to this question lies partly in the enormous ramifications in methods of navigation that have recently been developed, and navigators to-day must be capable of handling all of them. Hence the astronomer has still important work to do, not only in simplifying the principles but also in simplifying their application; and so navigational almanacs are essential to provide in the simplest manner, and to the necessary accuracy, the positions of those heavenly bodies which are used for navigation. A large portion of Part 2 is devoted to a description of the almanacs produced by various countries, and something is said about a few graphical and instrumental methods devised for the solution of the astronomical spherical triangle. In the last section of Part 2, "Observations", special reference is made to the latest sextants, in which random accelerations due to the motion of aircraft are smoothed out, the observations being automatically integrated over periods of one or two minutes. Unfortunately, the Coriolis acceleration cannot be smoothed out in this way, and special tables are required in this case.

Part 3, "The Future", deals, *inter alia*, with artificial satellites, about which the public has heard much in recent times. After considering certain problems connected with these bodies, the author sums up the situation in the words, "The almanac maker of the era of these artificial satellites would have his full share of problems—both in celestial mechanics and in tabulation".

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Cosmic Rays and the Magnetic Field of the Sun

THE variation of the cosmic-ray intensity at sea-level with geomagnetic latitude shows a sharp change in slope in the region of 50°, the intensity remaining very nearly constant between this latitude and the pole. This latitude cut-off is present at a height of 30,000 ft.[1] and, according to Cosyns[2], still occurs at the same latitude at a pressure-level of 7 cm. mercury. Carmichael and Dymond's balloon flights[3], when compared with those of Pfotzer, also indicate no increase in intensity between 50° N. and 88° N.

The absence, even at great altitudes, of any increase in intensity with latitude, at latitudes greater than 50°, has been taken as an indication that the momentum spectrum of the primary radiation must be cut off at $\sim 3 \times 10^9$ eV./c. Jánossy[4] has suggested that this cut-off in the momentum spectrum may be due to the sun's magnetic field, since this would be expected to set a limit to the momentum of particles which can approach the earth. In addition to this latitude cut-off, there should also be a daily variation in the cosmic-ray intensity as the earth rotates relative to the directions which are forbidden by the solar field. The amplitude of this daily variation should increase with altitude, since the contribution to the total intensity of particles with low momentum increases with height. Rossi[5] estimated that this daily variation should be as much as 20 per cent at 35,000 ft. at latitude 48·7° and concluded that this was not in agreement with observation.

More recent calculations by Kane, Shanley and Wheeler[6], following a suggestion by Alfvén[7], showed that the daily variation to be expected would be a good deal smaller than this, due to the effect of particles scattered into periodic orbits in the sun's field by the magnetic field of the earth. They calculated the intensity in the forbidden cone due to these particles and concluded that there should still be a small variation at high altitudes. It should therefore be possible to check the solar magnetic field hypothesis by measuring the daily variation and comparing it with the theoretically expected value.

In calculating the daily variation, it is necessary to know the trajectories of the particles in the earth's field, and since these data have not been calculated for our latitude, the information has been obtained from the results of terrella experiments carried out by Malmfors[8]. He gives, in graphical form, the direction of arrival in the earth's field of particles of momenta between 2 and 10×10^9 eV./c which strike the earth in a vertical direction. This information has been used to calculate the minimum allowed momentum as a function of solar time. Following the method used by Rossi[5], the contribution to the total vertical intensity by particles in a given range of momentum has been estimated from the latitude variation at 30,000 ft. as measured by Biehl, Neher and Roesch[1]. From Kane, Shanley and Wheeler's calculations we know the intensity in the forbidden cone as a function of momentum, and the vertical intensity at 30,000 ft. can therefore be calculated as a function of solar time. The differences in intensity between day and night estimated in this way are given in Table 2.

Measurements of the cosmic-ray intensity have recently been made at 30,000 ft. in a Mosquito aircraft during the day and during the night using a threefold-coincidence set. The set consisted of three trays of Geiger–Müller counters each with a sensitive area of 20 cm. × 20 cm., the distance between the top and bottom trays being 43 cm. The telescope contained no absorber apart from 3·5 cm. of steel plate which supported the lead blocks used for shielding the counters from side showers. The apparatus was carried in the aircraft bomb-bay and the counting-rate was $\sim$ 33,000 per hour at 30,000 ft. Each flight was made along approximately the same route (between Leeds and the south coast of England) at an indicated height of 30,000 ft. with the altimeter set to 1013 mb. The flights were made during the period November 1–3, 1949, and the results are given in Table 1.

Table 1

Total duration of flights	Time centred on	Mean height	Average rate/hr.
2h. 50m.	00h. 42m.	30,195 ft.	32,450 ± 213
2h. 50m.	14h. 45m.	30,279 ft.	32,660 ± 176

After correcting for the difference of 84 ft. in the mean heights for the day and night flights, the average counting-rates become 32,700 ± 213 per hour at night and 32,660 ± 176 during the daytime period.

The difference (day minus night) is $-0{\cdot}12 \pm 0{\cdot}83$ per cent. The errors quoted are the standard deviations obtained from the scatter in the numbers of particles counted during 5-minute periods throughout the flights. The expected differences calculated for two values of the sun's magnetic moment M_s are as follows:

Table 2

H equator (gauss)	M_s (gauss cm^3)	Intensity, day minus night	Latitude cut-off
38	$1{\cdot}3 \times 10^{34}$	+ 3·5 per cent	50°
30	$1{\cdot}0 \times 10^{34}$	+ 1·9 ,,	53°

The calculated values of 3·5 per cent and 1·9 per cent differ from the measured value by an amount which is 4·4 and 2·4 times the standard deviation respectively. It therefore seems unlikely, on the basis of present theory, that the latitude cut-off at 50° can be due to the sun's magnetic field. It is of interest to note here that Biehl, Neher and Roesch have used their aeroplane data to normalize earlier balloon results obtained by Millikan and his co-workers. The normalized curves obtained in this manner indicate that there is no latitude cut-off at heights appreciably greater than 30,000 ft. up to latitude 60°. This result would appear to be in contradiction with the results of Cosyns and of Carmichael and Dymond, which are quoted above.

It is a pleasure to acknowledge the enthusiastic co-operation of Group-Captain J. C. Macdonald and his staff at the R.A.F. Station, Coningsby. We also wish to express our gratitude to the Department of Scientific and Industrial Research for a grant

covering the cost of the apparatus, which was built by Cinema-Television, Ltd.

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Distribution of Radiation from the Undisturbed Sun at a Wave-length of 60 cm.

Some theories of the emission of radio waves from the sun in the absence of sunspots[1,2,3] predict apparent 'brightening' of the limb at wave-lengths of the order of 60 cm. and shorter. It is therefore of interest to measure the distribution of 'radio brightness' across the solar disk at these wave-lengths.

One possible method of measuring this distribution is to observe the variation of the intensity received during an eclipse, as has been done by Dicke and Beringer[4] on a wave-length of 1·25 cm., Sander[5] on 3·2 cm., Covington[6] on 10·7 cm., Laffineur, Michard, Steinberg and Zisler[7] on 25 cm. and 55 cm., and by Christiansen, Yabsley and Mills[8] on 50 cm. I have also made similar measurements on a wave-length of 60 cm. during the partial eclipse of April 28, 1949.

Unfortunately, except for eclipses which are nearly total, the fractions of the disk and of a ring at the limb which are eclipsed are nearly equal, so that a clear indication of 'limb-brightening' cannot be expected. The interpretation of the results of eclipse observations is also made difficult by the presence of sunspots, which may emit enhanced radiation. Christiansen, Yabsley and Mills, whose results were obtained during an eclipse which was nearly total, made careful allowance for the emission from sunspots, and they concluded that their results would be consistent either with the presence of 'limb-brightening' or with the emission from a disk of uniform apparent temperature having a radius 1·3 times that of the visible disk. They deduced that half the total radiation originated near or beyond the visible limb.

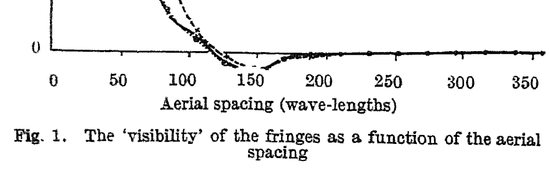

Fig. 1. The 'visibility' of the fringes as a function of the aerial spacing

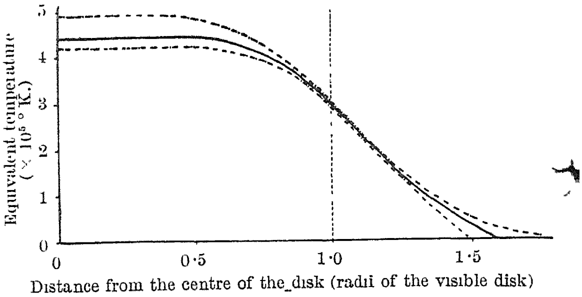

Fig. 2. Deduced distribution of radio 'brightness' across the solar disk —·—·, Estimated maximum error

In view of the difficulty of interpreting observations made during eclipses, the distribution of 'brightness' at a wave-length of 60 cm. has been investigated using a different method, which has the advantage that it can be employed at a chosen time when the contribution from sunspots is small. This method makes use of the principle employed by Michelson for measuring the angular diameters of stars. Two aerials, spaced many wave-lengths apart, are connected to the same receiver so that, as shown by Ryle and Vonberg[9], they produce a 'reception polar diagram' which is periodic in received power and which sweeps across the sun as the earth rotates. If the source were concentrated in the form of a strip parallel to the earth's equatorial plane, it can be shown that the relative amplitude of the variations in the received power (the 'visibility' of the fringes in Michelson's interferometer) would be proportional to that Fourier component of the intensity distribution in the strip which corresponds to the periodicity of the reception polar diagram.

Observations were made with a number of different aerial spacings, and from these it was possible to make a Fourier synthesis of the equivalent strip distribution of 'radio brightness'. From this distribution the radial distribution of brightness of the actual source can be derived if circular symmetry is assumed.

The experiment was carried out using aerial spacings up to 365 wave-lengths, on three separate occasions when the area of visible sunspots was small. The measured 'visibilities' for the different spacings are shown in Fig. 1. From each of the curves of Fig. 1 the distribution of brightness of an equivalent 'strip' source was found. By examination of these distributions it was possible to deduce the small contributions of the sunspots which were known to be present on each occasion, and hence to derive a curve corresponding to the radiation from the undisturbed sun. The radial distribution of 'brightness' for the undisturbed sun was then calculated from this curve. This 'brightness', expressed in terms of the temperature of a black body which would produce equal intrinsic brightness, is shown in Fig. 2.

It can be seen that at 60 cm. no limb-brightening occurs. The intensity at the limb is about 66 per cent of that near the centre of the disk; about 30 per cent of the total radiation comes from outside the visible disk.

The intensity of solar radiation is often expressed in terms of the temperature of an equivalent 'black' circular source subtending half a degree at the earth. This equivalent temperature, for a wave-length of

60 cm. and in the absence of sunspots, is found to be $5 \cdot 4 \pm 0 \cdot 5 \times 10^5$ deg. K.

This work was carried out as part of a programme of radio research supported at the Cavendish Laboratory by a grant from the Department of Scientific and Industrial Research. I am indebted to Mr. M. Ryle for considerable help, and to the Ministry of Education for a grant under the Further Education and Training Scheme.

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Heavy Fragment Disintegrations

A STAR (Fig. 1) has been observed in Ilford *G*5 nuclear research emulsion exposed on the Jungfraujoch. It consists of three lightly ionizing particles and three singly charged particles emitted nearly in the same direction. The ranges of these particles, which all end in the emulsion, are $31\,\mu$, $61\,\mu$ and $88\,\mu$ respectively, which is nearly in the ratio 1 : 2 : 3. The deviations from exact proportionality may be accounted for by straggling.

The range of a particle in the emulsion is given by an expression of the type

$$R = \frac{m}{e^2} f(v).$$

where m is mass, e is charge and v is velocity of the particle. If, therefore, these three particles have equal charges and initial velocities, their ranges will be proportional to their masses. This indicates that the particles have masses in the ratios 1 : 2 : 3 and are therefore proton, deuteron and triton respectively.

This observation may be explained by assuming that an excited lithium nucleus was ejected from a nucleus in the emulsion by a cosmic ray particle, and disintegrated as it left the parent nucleus:

$$Li_3{}^6 \rightarrow H_1{}^1 + H_1{}^2 + H_1{}^3 - 21 \cdot 3 \text{ MeV.,} \quad (1)$$

$$\text{or} \quad Li_3{}^7 \rightarrow H_1{}^1 + H_1{}^2 + H_1{}^3 + n_0{}^1 - 28 \cdot 4 \text{ MeV.} \quad (2)$$

No other lithium isotope can give a disintegration consistent with the observed tracks.

Examination of the modes of disintegration of $Li_3{}^6$ and $Li_3{}^7$ shows that in neither case is the above reaction energetically the most favoured. But, if the spins of the disintegration products in reaction (1) are all parallel, they total 2, whereas the maximum total for any of the energetically more favoured reactions is 1. If, therefore, the spin of the excited $Li_3{}^6$ nucleus is assumed to be 2, then reaction (1) will be permitted and the alternatives forbidden.

It is not possible to permit reaction (2) and forbid its alternatives in a similar manner.

The event may therefore be explained as the disintegration of an excited $Li_3{}^6$ nucleus of spin 2 according to equation (1). As this reaction is endothermic, the lithium nucleus must have been excited to more than 21·3 MeV. The excess excitation energy over this value, if any, would appear as kinetic energy of the disintegration products in the centre of mass system. This would have caused a distortion of the range ratios or an angular spread of the tracks, or both, depending on the angles of emission of the particles. None is, in fact, observed. It seems likely, therefore, that the excited state of the lithium nucleus is not much greater than 21·3 MeV.

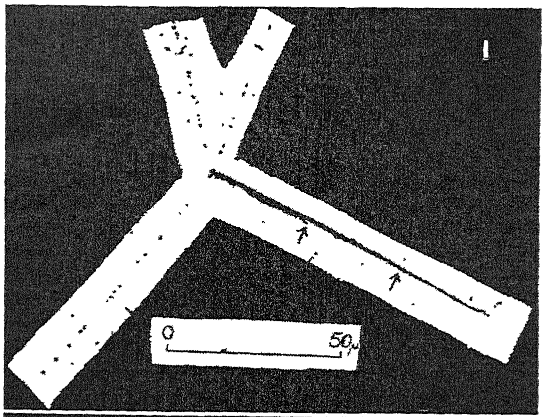

Fig. 1. A proton, deuteron and triton emitted in the same direction from a cosmic-ray star. The ends of the proton and deuteron are indicated by arrows. The deuteron ends very nearly in the triton track and so is not easily visible. Observer: Miss E. V. Le Good

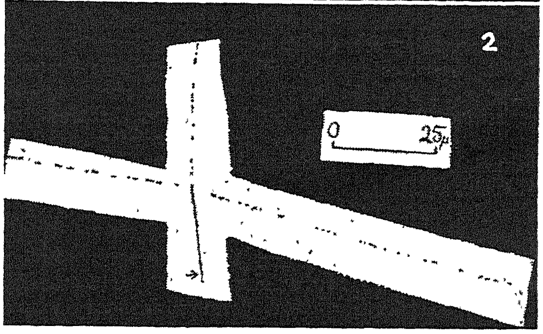

Fig. 2. Two singly charged particles emitted in the same direction. The tracks are in the same vertical plane and are not resolved in the picture. The end of the shorter track is indicated by an arrow. Observer: P. E. Hodgson

In another event (Fig. 2) observed in *C*2 emulsion, two tracks, of ranges $22 \cdot 5\,\mu$ and $24\,\mu$, are due to singly charged particles emitted nearly in the same direction. This event may be explained in a similar way by either of the reactions:

$$He_2{}^4 \rightarrow 2H_1{}^2 - 23 \cdot 8 \text{ MeV.}$$

$$He_2{}^6 \rightarrow 2H_1{}^3 - 12 \cdot 2 \text{ MeV.}$$

The probability that these events are due to the chance coincidence of evaporated particles is negligible for the first and very small for the second.

In both events the particles are emitted nearly in a horizontal plane.

I should like to express my thanks to Sir George Thomson and Mr. N. C. Barford for discussion of the above events.

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Radioactivity of Potassium

THE following determinations of the specific β- and γ-ray activities of potassium-40 are reported in view of the current interest in its decay scheme and the uncertainties which exist as to the magnitude of some of its constants[1-3].

Gamma-ray activity. A steel condenser-ionization chamber[4] of one litre volume, filled with nitrogen at 50 atmospheres pressure, was used to measure the γ-radiation from a 2-kgm. source of 'AnalaR' potassium chloride which closely surrounded it in the form of a thick-walled cylinder. The sensitivity of the arrangement was such that the potassium chloride contributed an ionization current of 150 ions/c.c./sec. above a background of 65 ions/c.c./sec. Calibration was made (*a*) by the insertion into the potassium chloride of four tubes containing pitchblende, standardized against a radium needle of known content, and (*b*) by an internal standard of sodium-24 intimately mixed with the potassium chloride. Taking the accepted figure[5] of 1·5 MeV. for the quantum energy of the potassium-40 γ-ray, the pitchblende calibration gave a value of 3·0 quanta/sec./gm. potassium, and the sodium-24 measurements gave $2 \cdot 9_5$ quanta/sec./gm. potassium. These results compare reasonably with values of 3·6 and 3 3 quanta/sec./gm. potassium given respectively by Gleditsch and Graf[5] and by Ahrens and Evans[2]. The original measurements of Gray and Tarrant[6] lead to a value 0·6 quanta/sec./gm. potassium, but this value is now known to be in error. Dr. Gray has kindly re-examined some of the earlier data, and the major part of the discrepancy has been accounted for.

Beta-ray activity. Disks of potassium chloride were made by pressing with a little binding material and placed below the end-window of a type *GM*4 Geiger–Müller tube. Calibration was again by means of an internal standard of sodium-24. Since the β-ray energies of potassium-40 and sodium-24 are nearly equal, the effects of self-absorption and reflexion are eliminated in a comparison of their activities when incorporated in the same specimen. The results do not then depend on the specimen thickness :

Specimen thickness (mm.)	1	2	3	4
β-ray activity mμC./gm. KCl	0·431	0·426	0·438	0·436

Corrections were determined experimentally to allow for the effect of γ-rays on the observed counts. The mean value obtained for the potassium-40 β-ray activity was 30·5 β-particles/sec./gm. potassium.

Stout[7] has recently published similar β-ray measurements, using thin specimens and calibration by internal sodium-24 standard. He reports a β-ray activity for potassium-40 of 30·0 ± 6 β-particles/sec./gm. potassium, in very close agreement with the value reported above. Ahrens and Evans[2] have made an estimate of 34 β-particles/sec./gm. potassium based on a critical examination of earlier values by Mühlhof[8] (25 β's/sec./gm. potassium) and by Bleuler and Gabriel[9] (59 β's/sec./gm. potassium).

Ahrens and Evans[2] have proposed a branching decay scheme for potassium-40 (based on some observations of the calcium-40 to potassium-40 ratio in Pre-Cambrian lepidolites) in which 42 per cent of the potassium-40 atoms disintegrate by β-ray emission to calcium-40, 54 per cent by electron capture to the ground-state of argon-40 and 4 per cent by electron capture to a metastable state of argon-40 and then to the ground-state with γ-ray emission. On this basis, Ahrens and Evans deduce a total half-life of $5 \cdot 1 \times 10^8$ yr. ; the experimental values of the β- and γ-ray activities reported above lead, on the same scheme, to a total half-life of $5 \cdot 5 \times 10^8$ years. Both figures are more than twice the half-life of $2 \cdot 4 \times 10^8$ yr. deduced by Bleuler and Gabriel[9], and this longer half-life is sufficient to remove most of the difficulties which must arise, as Poole[1] demonstrates, in any attempt to reconcile a potassium half-life of $2 \cdot 4 \times 10^8$ yr. with present estimates of the age and potassium content of the earth's crust. On the basis of data given in Poole's letter and a potassium half-life of $5 \cdot 5 \times 10^8$ years, potassium-40 disintegration would account for about half the argon now present in the earth's atmosphere. Verhougen has pointed out[3] that the half-life suggested by Ahrens and Evans still leads to remarkable conclusions about the solidification of the earth's crust. The relative magnitude of the electron-capture branch of Ahrens and Evans's scheme for potassium-40, however, is not yet fixed very precisely, and can only be determined accurately by measurement of the argon *K*-radiation which follows the electron capture process.

Finally, it may be added that with an average potassium content of tissues of about 0·11 per cent, the β- and γ-radiations of potassium-40 contribute a weekly dose to humans of approximately 0·25 mr. or one-third that received in the same time from cosmic radiation at sea-level. The inclusion of the argon *K*-radiation of 3·2 ekV. would raise this figure by less than 1 per cent. The γ-radiation from potassium in the body is the equivalent of about 6×10^{-3} μgm. radium, a figure of the same order of magnitude as the supposed normal radium content of the skeleton.

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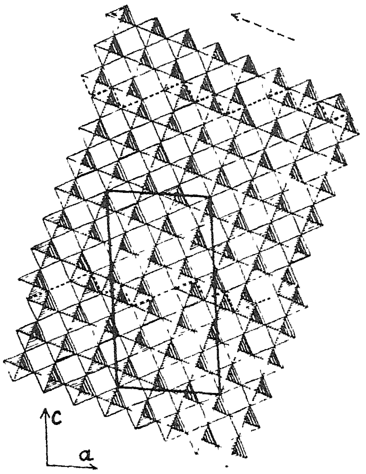
Structure of β-Tungsten Oxide

BY prolonged heating at 1,000° C. of the blue β-tungsten oxide of composition $WO_{2\cdot 90}$, formed by heating appropriate mixtures of tungsten powder and tungsten trioxide *in vacuo*, minute crystal needles were produced, suitable for single crystal investigation[1]. On the basis of X-ray data obtained in this way, it has been possible to work out the structure of this compound.

The Weissenberg photographs of the oxide are rather peculiar in appearance, the reflexions generally occurring in doublets or triplets. When represented in reciprocal space, the groups of reflexions were found to be situated in the immediate vicinity of the reciprocal lattice points corresponding to an approximately cubic unit cell with the edge-length equal to 3·75 A., while the dimensions of the actual monoclinic unit cell are $a = 12 \cdot 1$ A., $b = 3 \cdot 78$ A., $c = 23 \cdot 4$ A., $\beta = 95°$. The regular decrease with increasing θ in the intensities of the strongest reflexion in each group and the dimensions of the substructure cell suggested that the structure is closely related to the DO_9-type (ReO_3-type)[2]. From this starting-point



the positions of the tungsten atoms could be derived through successive Fourier calculations of the electron density function. Sites of the oxygen atoms were found from space considerations. In this way a structure of the symmetry $P2/m$ was arrived at, having the cell content $W_{20}O_{58}$ and giving satisfactory agreement between observed and calculated structure-factor values.

The accompanying figure represents an idealized picture of the structure. The lattice may be described as consisting of 'blocks' of WO_6 octahedra joined by sharing corners, the 'blocks' being infinitely extended in two dimensions, and of a characteristic width of twenty octahedra in a third direction (indicated by a dotted arrow in the figure). The 'blocks' are mutually connected by octahedra-sharing edges. The projections of the folded planes common to the 'blocks' are marked with dotted lines. The WO_6 octahedra are almost regular except those sharing edges with other octahedra, which are somewhat distorted.

The structure is related to those of β-molybdenum oxide (Mo_8O_{23}) and β′-molybdenum oxide (Mo_9O_{26})[3], but differs concerning the width and the mutual combination of the 'blocks'. Furthermore, the octahedra of the molybdenum oxides are generally less regular than those of the tungsten oxide. This may be compared with the structures of the trioxides; tungsten trioxide, crystallizing with a deformed DO_9-lattice[4], whereas molybdenum trioxide has quite another structure[4,5]. Tungsten thus seems more capable than molybdenum of forming a DO_9-lattice. This is also of interest considering the non-existence of a molybdenum analogue of the highly stable sodium tungsten bronze of perovskite type, which may be at least formally described as an interstitial solution of alkali ions in a DO_9-lattice[6].

A detailed report of the investigation will be published elsewhere[7].

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A Radioactive Method for Measuring the Adsorption of Dissolved Substances on Liquid Surfaces

SEVERAL valuable and interesting methods[1] have been devised for the measurement of the adsorption of soluble substances on the surface of a solution, from the moving bubble method initiated by Donnan and his students to the microtome and interferometer methods by McBain *et al.* For measurements on static interfaces, the microtome and interferometer methods seem to have been the only applicable ones, and several fundamental problems have been attacked with these methods. For extensive study in this wide field, however, any simple and accurate method is welcome.

The radioactive method to be described here is based on the use of isotopes emitting non-penetrating radiations, like alpha-emitters and the soft beta-emitters such as carbon-14, sulphur-35, calcium-45 and hydrogen-3.

The principle of the experimental arrangement used is the following. A thin-window bell-type Geiger–Müller tube is placed immediately above a circular cup filled exactly to the brim with a solution of the surface-active compound tagged with a built-in radioactive isotope or with a solution of a radioactive ion. The Geiger–Müller tube counts the particles from the surface-adsorbed molecules or ions, and also those from the interior of the solution. However, the fraction of the particles from the interior that is counted decreases very rapidly with the depth below the surface, so that under favourable conditions nearly all the particles counted originate in the surface-adsorbed layer. The fraction of the particles coming from the interior is determined by making a similar measurement with a solution of the same isotope in a non-surface-active compound.

The recoil atoms from alpha- and beta-disintegrations in the natural radioactive series might also be used, but they cannot be counted directly with conventional Geiger–Müller tubes; since they are usually radioactive in turn and charged, however, they can be collected on an electrode in the gas over the surface and measured radioactively.

The method applied to $C_{18}H_{37}SO_4Na$ (probably not entirely free from homologues) labelled with sulphur-35 gave quantity adsorbed on the surface as $6{\cdot}05 \times 10^{-10}$ moles/cm.² in a $1{\cdot}6 \times 10^{-5}\,N$ solution at 18° C. From surface tension measurements with a Du Noüy tensiometer in the concentration range from $0{\cdot}5 \times 10^{-5}$ to $5 \times 10^{-5}\,N$, the surface-adsorbed quantity was calculated with Gibbs's adsorption equation:

$$-\Gamma = \frac{\partial\gamma}{\partial\mu};\quad \partial\mu = RT\,(\partial\ln c + \partial\ln f),$$

where γ is surface tension in dynes/cm., μ is Gibbs's partial free energy of the solute, c is concentration and f is activity coefficient of the solute.

In these dilute solutions well below the critical concentration for micelle formation[2] $\partial\ln f/\partial\ln c$ is negligible, so that

$$\Gamma = -\frac{1}{RT}\,\frac{\partial\gamma}{\partial\ln c}.$$

Hence $\Gamma = 5{\cdot}8 \times 10^{-10}$ mole/cm.², which is in fair agreement with the directly measured $6{\cdot}05 \times 10^{-10}$ mole/cm.², considering the sulphate was not quite pure and that the surface-tension measurements were not very accurate at such low concentrations.

A more crucial test of Gibbs's law will be undertaken with homologue-free C_6- and C_{14}-sulphates. In addition, investigations are being made on mixtures of surface-active agents in solution, co-adsorption of ions, etc., using the radioactive method.

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Light Output from a Spark 'Point Source'

IN view of the increasing use of high-speed shadow and *schlieren* photography by short-duration flashes from electric discharges, it seemed desirable to determine the various factors affecting the light output, so that desired characteristics could be obtained in the most convenient way.

It has been found that the light emitted by a given spark gap depends on the current in the gap and on its variation with time. The light is only affected by the voltage, capacitance and inductance of the discharge circuit in so far as these affect the current. For example, the same light output is obtained by the discharge of a 0·1 μF. condenser at 10 kV. through a circuit inductance of 0·4 μH. as by the discharge of a 0·033 μF. condenser at 30 kV. through a circuit inductance of 1·2 μH. giving the same oscillatory current of 5 k.amp. with period of 1·3 μsec. The upper curves in Fig. 1 indicate the dependence on current of the relative maximum light output (as measured by a photomultiplier, amplifier and cathode ray oscillograph) from a 1-mm. gap in air between rod electrodes carrying a lightly damped oscillatory current of period 1·3 μsec. The variation of light output with time is shown in Fig. 2, curve (*b*), which indicates that a substantial proportion of the total light is emitted in the first half-cycle of the discharge.

The peak light output is reduced if the time to maximum current exceeds 1 μsec., and the lower curves in Fig. 1 give the relative maximum light output for a discharge of period 40 μsec. With such a discharge between copper electrodes, the second and third half-cycles produce as much light as the first, suggesting that a stable arc condition has been established in a few microseconds. It is believed that, with discharges of the shorter period, a higher voltage remains on the gap during the first quarter-cycle, so that more energy is dissipated in the gap. It is intended to make voltage measurements.

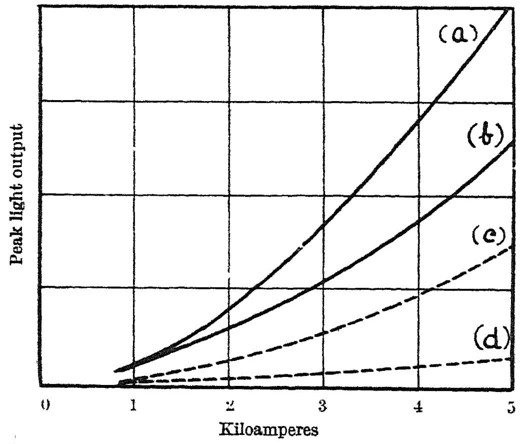

Fig. 1. Variation of peak light with current in 1-mm. gap: (*a*) and (*c*) cadmium electrodes; (*b*) and (*d*) copper electrodes; (*a*) and (*b*) discharge oscillation period 1·3 μsec.; (*c*) and (*d*) discharge oscillation period 40 μsec.

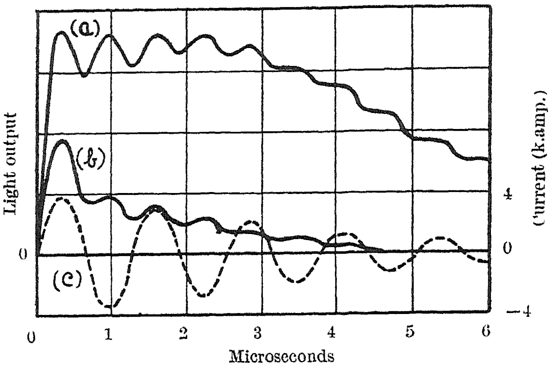

Fig. 2. Variation of current and light with time: (*a*) light from constricted 3-mm. axial gap; (*b*) light from open 1-mm. gap; (*c*) current

The maximum light output is greater for the more volatile metals, and the rate of decrease is less. For example, cadmium electrodes 1 mm. apart give about 50 per cent higher maximum, and 100 per cent more total light than copper electrodes.

An alternative form of spark, emitting light axially through a 1-mm. hole in one electrode, has been examined. If the spark is not constricted, it is usually not axial, and less light is available than is emitted radially from a 1-mm. gap between rods. With the discharge constricted by an insulating tube, measurements have been made on sparks 1½–8 mm. long. The maximum light emitted was about twice that from the open 1-mm. gap. The total light, as measured by a photo-electric integrating flashmeter, increased with gap-length, varying from five to eight times that for the open gap. A photomultiplier oscillogram showed that the increase in total light was obtained at a cost of increased duration, as much light being emitted during the second discharge half-cycle as in the first (Fig. 2, curve *a*).

The measurements of total light, for a discharge current of 4 k.amp., period 1·3 μsec., indicate that the 1-mm. open gap with copper electrodes, the 1-mm. open gap with cadmium or magnesium electrodes, and the constricted axial gaps with brass electrodes, were respectively equivalent to about 0·1, 0·2 and 0·6–0·9 candle-second.

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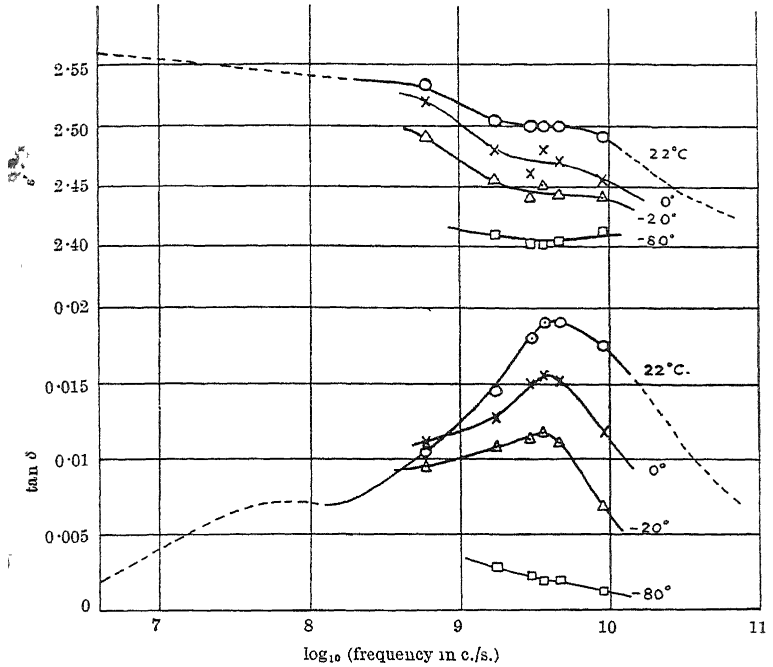
Dielectric Behaviour of Methyl Palmitate in the Microwave Region

THE variation of the dielectric constant and loss of methyl palmitate at room temperature over the frequency range 50 c./s. to 3×10^{10} c./s. was first reported by Dryden and Willis Jackson[1]. The evidence provided for resonance absorption in the frequency range centred on 10^{10} c./s. led us to investigate the absorption at room temperature and at as many



frequencies as practicable in the microwave region. All measurements except those at 10^{10} c./s. were made in a coaxial line using the standing-wave method of Roberts and von Hippel[2]. At 10^{10} c./s. the same method was used in a rectangular wave-guide carrying the H_{01} mode. The accuracy of this method is greatest when the specimen length is an odd number of quarter wave-lengths. Therefore at all frequencies the measurements were done with specimen lengths complying as nearly as possible with this condition. Cast specimens were first used, but were found to give inconsistent results. This was thought to be due to the non-uniform nature of the material prepared in this way, the average densities being much less than the crystal density of 1·007 gm./c.c. calculated from the spacing obtained by Malkin[3]. Specimens pressed from powder were found to have densities of 0·985 ± 0·005 gm./c.c. and have, therefore, been used throughout the investigation.

The results of measurements at 22 ± 1° C. are shown in the accompanying graph. The experimental points represent the mean of several measurements with different specimens, and are in good agreement with the values in the microwave region given in a recent communication by Willis Jackson[4].

The value of tan δ at 600 Mc./s. reported here is, however, higher than the value obtained by interpolation in Jackson's curve. The parts of the curves of ε' and tan δ at 22° C. shown dotted in the graph are based on Jackson's results at frequencies outside the range covered in this investigation.

The plateau in the ε' curve in the frequency-region of maximum loss is, we believe, real. Although the absolute accuracy of the determination of ε' is not better than ± 1 per cent, the relative accuracy should be higher than this, since the same specimen was used in each series of measurements. This plateau suggests that the absorption mechanism may not be entirely of the Debye type.

To obtain further information regarding the absorption process, measurements were next carried out, using the same technique, at a number of lower temperatures. The results of the measurements at 0°, −20° and −80° C. are shown in the graph. The absolute accuracy of ε' is considered to be ± 1 per cent; but again the relative accuracy at any one temperature is probably better than this. The tan δ values are accurate to ± 5 per cent, except at −80° C., where the accuracy is somewhat lower.

The noticeable features of the experimental curves are: (*a*) The frequency of maximum absorption is independent of temperature. (*b*) The magnitude of the peak in the loss curve decreases with fall of temperature. (*c*) The plateau in the ε' curve persists at lower temperatures. There is even a suggestion of a kink at the frequency of maximum loss.

It is difficult to discuss the possible absorption mechanisms which might account for the experimental results until further work at lower temperatures has been carried out at frequencies less than 600 Mc./s. The change in tan δ with temperature at the lowest frequency (600 Mc./s.) used indicates that absorption of the Debye type is present, the loss-spectrum due to it moving to regions of lower frequency as the temperature falls. This also causes the symmetry of the tan δ curve to change with temperature. The persistent peak in the loss-curve around 4 × 10^9 c./s. is, however, not explainable by means of a relaxation process of the Debye type, and must, it is thought, be due to resonance occurring at a frequency within the relaxation spectrum. According to Fröhlich[5], however, loss due to pure resonance should increase at the resonant frequency as the temperature falls (the loss-curve becoming narrower in the process), whereas the present results do not show this effect. This may be due to resonance absorption occurring in the same frequency-range as Debye absorption.

To test the significance of the fact that methyl palmitate crystallizes in double molecules, further work is in progress on the behaviour of the methyl esters of other fatty acids, including those which do not crystallize in this manner.

Our thanks are due to Prof. J. E. Roberts for his interest in the investigation, to the Research Laboratories of Messrs. Unilever, Ltd., for providing the pure material, and to the Admiralty Signal and Radar Establishment for the loan of apparatus.

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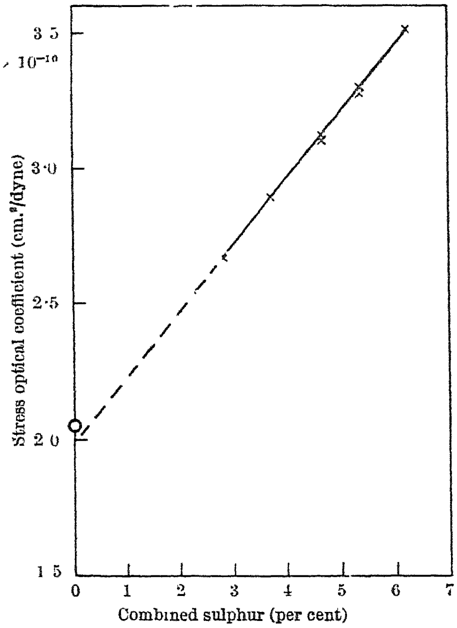
Birefringence in Rubbers

It has been shown, both theoretically[1] and experimentally[2,3], that in simple elongation of a sample of a pure gum vulcanizate, an approximately linear relationship between the tensile stress t and the birefringence $(n_1 - n_2)$ obtains, provided the strain is not sufficiently large to produce crystallization. We may write

$$(n_1 - n_2) = Ct, \qquad (1)$$

where C, the constant of proportionality, is termed the 'stress-optical coefficient', and is theoretically independent of the degree of cross-linking (vulcanization) of the vulcanizate and should be identical for all pure rubbers.

Thibodeau and McPherson[3] have shown that the stress-optical coefficient is dependent upon the type of vulcanization. In particular, for gum vulcanized by means of sulphur without accelerators but in the presence of stearic acid and zinc oxide, they found the stress-optical coefficient to depend linearly on the amount of combined sulphur. This dependence upon degree of vulcanization suggests that the sulphur is modifying either the polarizability or the stiffness of the molecular chains of the network. An extrapolation of the linear relation to zero combined-sulphur content has been used by Treloar as a measure of the birefringence of the actual molecular network



×—×—, Sulphur vulcanizate (Thibodeau and McPherson)
O, peroxide vulcanizate (Saunders)

Recently a vulcanized rubber has been produced which is free from all additions to the rubber; particularly it is free from sulphur. The vulcanization is achieved by a peroxide reaction[4], and all the by-products can be removed, leaving a pure hydrocarbon vulcanizate. It is interesting to determine the stress-optical coefficient for this material and compare it with the results obtained by Thibodeau and McPherson.

The birefringence of a thin strip of the peroxide vulcanizate elongated under a known load was measured using crossed Nicol prisms and a Babinet compensator. The relation between the stress and the birefringence was found to be linear and reversible up to strains of about 100 per cent, and the stress-optical coefficient was $2 \cdot 05 \times 10^{-10}$ cm.²/dyne. This compares very well with the value obtained by extrapolating the results of Thibodeau and McPherson to zero combined-sulphur content.

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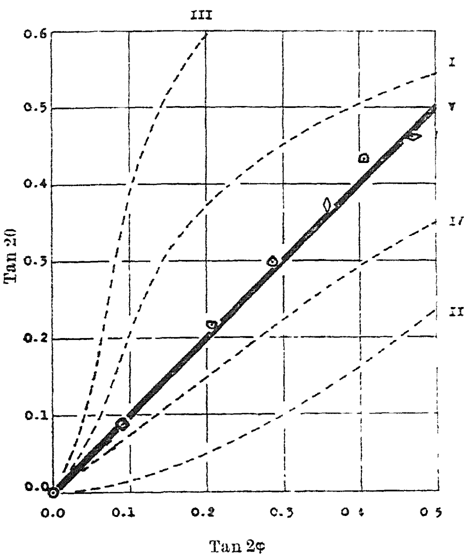
Elastico-Plastic Straining when the Principal Stresses Rotate

In recent years there has arisen a controversy, on theoretical grounds[1], on whether post-yield straining of metals should be analysed by considering: (I) plastic increment-strain components only (Levy, about 1870, and Mises later[2]); (II) plastic total-strain components only attained instantaneously (Nadai, 1931 [3]); (III) plastic + elastic increment-strain components (Prandtl, 1924, and Reuss, 1930 [4]); (IV) plastic + elastic total-strain components attained incrementally (Swainger, 1945 [5]). It is shown in this communication that, from experimental evidence, none of these theories is correct; but that a simple modification to my theory in (IV) leads to correct predictions; that is, one must consider (V) plastic increment-strain components + elastic total-strain components attained incrementally.

This step was not taken arbitrarily, but reached from the consideration that continuity of straining-displacement[6] must be assured for a body *as a whole*, and its instantaneous shape under elastico-plastic straining should be the reference for the next increment of deformation.

A searching test of a theory predicting post-yield strain values is given by rotating the principal normal-stress system relative to the substance at a given point in the body. Peters, Dow and Batdorf[7] undertook the test by loading with combined axial compression and torsion on two thin-walled duralumin cylinders. Each cylinder was made to yield by axial compression stress S_{xx}, and then complex rotating stresses were induced by applying axial torsion to induce shear stress S_{xy}. In two tests the axial compression stress was maintained constant while applying shear, and the compression strain e_{xx} allowed to increase correspondingly as the shear strain $2e_{xy}$ increased. In a third test, the longitudinal compression strain was maintained constant while applying shear, and the longitudinal compression stress allowed to decrease correspondingly. The maximum strains were approximately $1 \cdot 6$ per cent compression and $0 \cdot 7$ per cent shear on the classical definition. Dr. Peters was kind enough to send me a copy of the N.A.C.A. paper in advance of publication[7].

Each theory states that the 'principal' directions θ, of the strains it considers, coincide with φ, those of the principal normal stresses in an isotropic sub-



stance. Hence correctness of this fundamental hypothesis for a given theory is shown by a point, calculated from experimental values, falling on the heavy line in the accompanying graph. Peters, Dow and Batdorf calculated the curves I and II. I have calculated III, IV and V after scaling values from the printed curves.

The points on curve V were found by measuring elastic total-strains e^E_{xx}, $2e^E_{xy}$ and plastic increment-strains de^P_{xx}, $2de^P_{xy}$ and, with the stress values substituted in

$$\tan 2\theta = \frac{2e^E_{xy} + 2de^P_{xy}}{(e^E_{xx} - e^E_{yy}) + (de^P_{xx} - de^P_{yy})}$$

$$\tan 2\varphi = \frac{2S_{xy}}{S_{xx}}. \qquad (1)$$

The scatter may be due in part to measuring values from printed curves in the absence of the arithmetical values.

There are two deficiencies in the theories 1–4. In 2 and 4 it was not seen clearly that only the plastic increment-strain is associated with the principal normal stresses. The total plastic strain has merely led to the instantaneous reference shape of the body. In 1, 2 and 3 it was not seen that the single-valuedness of displacement for body continuity precludes the extraction and consideration alone of a strain component of 'quality' or magnitude from the strain defining the instantaneous shape of the yielded body, which must be seen as a whole in the sense of ref. 6.

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Relativistic Interactions Between Two Nucleons

SEVERAL papers[1-4] dealing with the relativistic study of the two-body problem have recently been published. They may be classified in two groups according to the point of view adopted: stable state of the deuteron, or collision process.

A convenient method for dealing with both aspects is to expand the wave function Ψ of the deuteron with respect to the eigenfunction $\overset{(j)}{\varphi}_m$ of the nucleons (1) and (2) in momentum space:

$$\Psi = \Sigma\, \Psi_{m_1m_2} \overset{(1)}{\varphi}_{m_1} \overset{(2)}{\varphi}_{m_2}, \qquad (1)$$

with $\Psi_{m_1m_2} = -\Psi_{m_2m_1}$ and $\overset{(j)}{\varphi}_m = \chi_m \exp i\,(p_m x^j - E_m t)$ without reducing the corresponding wave equation as was done by Kemmer[5].

(*a*) As Van Hove[1] did on the lines of the neutral pseudoscalar and vector meson theory, it is then possible to obtain a matrix element for the interaction between nucleons in which the direct coupling terms may disappear, showing that these terms do not play any part in the ground-state of the deuteron. However, Van Hove's general conclusions are not quite justified. For example, in the case of the pseudoscalar field, he maintains that the interaction completely vanishes to the static approximation, owing to the presence of the ρ_2 Dirac matrices in an expression of the type:

$$(\Psi \mid W_1 \mid \varphi) = \qquad (2)$$

$$-f_3^2\, \Sigma\, \Psi_{n_1n_2} \overset{(1)}{\chi}{}^*_{n_1} \overset{(2)}{\chi}{}^*_{n_2} \frac{\overset{(1)}{\rho_2}\ \overset{(2)}{\rho_2}}{\varepsilon_k^2 - (E_{m_1} - E_{n_1})^2} \overset{(1)}{\chi}_{m_1} \overset{(2)}{\chi}_{m_2} \varphi_{m_1m_2}$$

$$f_3 = f_1 + 2f_2 \frac{M}{\varkappa},$$

where f_1, f_2 are the coupling constants between the pseudoscalar meson field and the nucleons, M and $\varkappa$ the masses of the nucleon and meson respectively, and ε_k is the total energy of the virtual meson involved. First of all, the assumption which consists in putting $\rho_2 = 0$ for all the components of (2) is too drastic when dealing with the stable states of the deuteron, which cannot in any event be represented by pure plane waves. Secondly, as was pointed out by Araki[2], the product $\left(f_2 \frac{M}{\varkappa}\right)^2 \overset{(1)}{\rho_2} \overset{(2)}{\rho_2}$ does not tend to zero for vanishing momenta; this fact is due to the mixture of the so-called 'small' and 'large' components in the wave function of the deuteron. It can also easily be seen by using a Gordon decomposition (cf. Rosenfeld[6]). Araki[2] pointed out that the r^{-3} singularity of the pseudoscalar static field is no longer valid at small distances of approach, being replaced by an r^{-1} singularity. Similar criticisms may be made for the vector field case.

(*b*) On the other hand, keeping only one term (Born approximation) in the expansion (1), one can obtain the relativistic cross-section for a neutron–proton collision. The results have been published for scalar[3] and pseudoscalar[4] meson fields. At least two procedures may be used to compare the calculations with the experimental data: (i) The interaction constants are adjusted in order to obtain agreement between the theoretical and experimental *differential* cross-section[4] for some value of the angle of collision, and the results in the remaining angular domain are examined. This permits us to see the angular dependence of the cross-section for each kind of field. (ii) It also seems useful to try to relate the results at low energies with those at higher energies, in looking for the role of the relativistic corrections in the *total* cross-section[3]. Using, for example, a mixture of symmetrical pseudoscalar and vector fields, we get for the total cross-section, in the system of the centre of gravity, and neglecting terms of the fourth order in the momentum p of nucleons :

$$S = S_{NR}\left(1 - \frac{p^2}{M^2}\right) + \frac{p^2 + M^2}{8\pi}\left\{\frac{10A}{\varkappa^2(\varkappa^2 + 4p^2)} - \frac{5A'}{4p^2}\left[\frac{1}{p^2}\log\frac{\varkappa^2 + 4p^2}{\varkappa^2} - \frac{4}{\varkappa^2}\frac{\varkappa^2 + 2p^2}{\varkappa^2 + 4p^2}\right] + \frac{B}{p^2(\varkappa^2 + 2p^2)}\log\frac{\varkappa^2 + 4p^2}{\varkappa^2}\right\}\frac{p^2}{M^2}$$

with

$$A = g_1^3\left(g_1 - 4g_2\frac{M}{\varkappa}\right) + g_2^2\left(4g_2^2\frac{M^2}{\varkappa^2} - f_3^2 - 2g_1^2 + 8g_1g_2\frac{M}{\varkappa}\right)$$

$$A' = g_1^4 + g_2^4 + g_1^3\left(g_1 - 4g_2\frac{M}{\varkappa}\right) - g_2^2\left(4g_2^2\frac{M^2}{\varkappa^2} - f_3^2 - 2g_1^2 + 8g_1g_2\frac{M}{\varkappa}\right)$$

$$B = g_1^2\left(4g_2^2\frac{M^2}{\varkappa^2} - f_3^2 - g_1^2 + 4g_1g_2\frac{M}{\varkappa}\right) - g_2^2\left(4g_2^2\frac{M^2}{\varkappa^2} - f_3^2 - 5g_1^2 + 20g_1g_2\frac{M}{\varkappa}\right) + 8g_1g_2\frac{M}{\varkappa}(g_1^2 + 3g_2^2),$$

where g_1, g_2 are the coupling constants between the vector meson field and the nucleons.

The corresponding non-relativistic cross-section is:

$$S_{NR} = \frac{p^2+M^2}{8\pi}\left\{(g_1^4+3g_2^4)\frac{10}{\varkappa^2(\varkappa^2+4p^2)} + \frac{g_1^4-3g_2^4+6g_1^2g_2^2}{p^2(\varkappa^2+2p^2)}\log\frac{\varkappa^2+4p^2}{\varkappa^2}\right\} \qquad (4)$$

and it does not involve any pseudoscalar coupling constants.

Using, for example, the constants of interaction of the Møller–Rosenfeld theory, $f_1 = g_1 = 0{\cdot}62$; $f_2 = g_2 = 1{\cdot}08$, corresponding to a meson mass 286 m_e, one gets, for incident neutrons of 90 MV. (laboratory system), $S_{NR} = 13{\cdot}5 \times 10^{-26}$ cm.^{2}. The experimental value[7] is approximately 9×10^{-26} cm.^{2}. The non-relativistic cross-section, as in the usual theories, is too large. If we take into account the relativistic terms, we obtain $S = 16{\cdot}2 \times 10^{-26}$ cm.^{2}, showing a further increase in the cross-section. This result is not changed by a more exact evaluation of the cross-section in terms of the velocities of the nucleons. In order to draw more definite conclusions, however, it seems necessary to revise the usual treatment of the ground state of the deuteron by taking account of the velocity-dependent and contact interactions.

I wish to thank Prof. L. Rosenfeld for many valuable discussions, and am also indebted to the Centre National de la Recherche Scientifique for a grant which entitled me to stay at the University of Manchester.

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Meyer Analysis of Metals

Messrs. Finniston, Jones and Madsen discuss in a recent communication[1] the variation of ultimate hardness number Pu with the Meyer index n, in the ball indentation test. There are several good reasons for associating a decrease in the n value with a decrease in the work-hardening capacity of a metal, especially since n and Pu have hitherto shown a negative correlation coefficient. Finniston *et al.*, however, suggest that this generalization should be reconsidered, and they give results showing a positive correlation coefficient between Pu and n for metals of non-cubic structure and of increasing anisotropy as judged by results for thermal expansion. Their proposal is interesting because certain anomalies exist regarding the n value. Thus, during the progressive cold rolling of copper it may drop from 2·34 to 2·0 at an early stage and then remain more or less constant, while the Pu value will continue to increase and thus indicate further work-hardening[2]. This peculiarity has not been explained, and it should be remarked that the progressively rolled copper increasingly develops anisotropic properties (preferred orientation) as shown by X-ray diffraction and etching tests. This effect does not appear to be inconsistent with their proposal.

Furthermore, there is evidence that when a stainless steel 18/8 alloy is progressively cold-worked, the Pu value rises steadily while n first falls and then *rises*. During the tempering of high-carbon steel, Pu will fall progressively but n will first fall and then rise slightly. Finally, in the course of investigations with the new hardness microtesters, results are being obtained where the Meyer index to the pyramid indentation *increases* with cold working as compared with a fall in the normal ball test.

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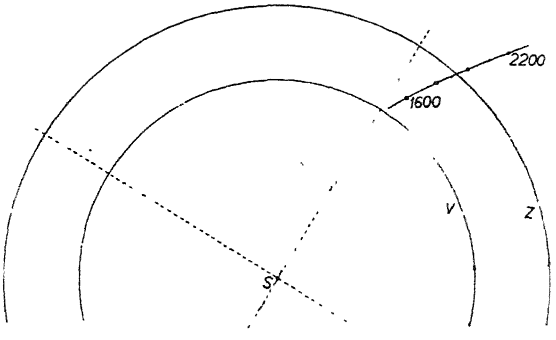
The Geminid Meteor Shower

IN 1947, Whipple[1] published new elements of the Geminid meteor shower, obtained photographically. An extremely short period, 1 65 years, moderate inclination and considerable eccentricity (see below) together make the orbit of this shower an extraordinary one both in comparison with comets and with minor planets. But, according to Hoffmeister[2], the existence of similar meteor showers seems to be indicated. Such a short-period meteor shower as the Geminids presents new aspects in meteor astronomy. Planetary perturbations are likely to play a great part in its nature. The study of secular perturbations is especially important, both in investigating the connexion with comets, and also from the observer's point of view; for example, Adams's classical work on the Leonids.

I have computed secular perturbations of the Geminids, due to Jupiter and the earth, using the Gauss–Hill method. The following table contains Whipple's elements of the Geminid orbit and their variations in a hundred years.

Elements, epoch 1937	Secular perturbations by		Elements, epoch 1937	Secular perturbations by	
	Jupiter	Earth		Jupiter	Earth
π 225° 02′	−0·1′	−1·1′	e 0·900	−0·001	0·000
Ω 260° 43′	−95·0′	−2 2′	a 1·396	—	—
i 23° 28′	+47 8′	+0 7′			

Although the earth approaches the shower very closely in its descending node, the secular perturbations due to it, owing to the small mass, are negligible compared with the effect of Jupiter. As the Geminids do not come near any other planet, perturbations caused by these are likely to be even smaller. The orbit rotates rather rapidly around the line of apsides, the direction of which remains nearly constant.



Secular motion of the descending node of the Geminid orbit on the plane of the ecliptic between the years 1600 and 2200. *V*, orbit of Venus; *Z*, orbit of earth

From the observer's point of view, the most important phenomenon is the rapid backward shift of the node. In consequence, the date of maximum activity of the shower moves backward by one day in about sixty years. Moreover (see diagram), the corresponding point of intersection of the Geminid orbit with the plane of the ecliptic does not move parallel with the earth's orbit, but cuts it at a steep angle. Consequently, the least distance of the shower from the earth changes, as the following table shows:

Year	Longitude of the node	Date of the maximum activity	Radius vector of the shower	Distance from earth
			astro unit	
1700	264° 33′	XII 17·7	0 8503	0·1337
1900	261° 18′	14·5	0·9665	0·0178
2100	258° 03′	11·4	1·0912	−0·1066

(Data are reduced to the epoch 1950, see ref. 3.)

The Geminids first appear each year about December 1. On that date, the earth is still about 0·1 astro. unit from the centre of the shower. Let us take this distance as a limit for the visibility of the shower. Then, according to the table, the appearance of the Geminids is limited in time-range to about four centuries. They probably appeared after 1700 and will disappear again about 2100. At present, the orbits of the earth and the Geminids very nearly intersect, and consequently the shower should be of maximum intensity. Before 1700, the Geminids came nearer to Venus than to the earth.

Observations are too few to confirm these theoretical deductions. The time of maximum activity of a shower differs somewhat from the date of the earth's passage through the node. By means of a new method, I have determined the date of maximum and the position of the radiant point with sufficient accuracy. A secular backward shift of the node seems to be indicated by the observations. The secular motion of the radiant point is too small in the time-interval covered by observations for confirmation. There is, however, another striking fact: at the present time, the Geminids are, after the Perseids, the strongest steady meteoric shower. The much feebler Lyrids, for example, have been known for many centuries, while no reports about the Geminids seem to have existed before 1830. Even the nineteenth century has paid little attention to this remarkable shower. This may be partly due to bad and cold December weather, and partly to cosmic causes.

The existence of a parent comet in such a short-period orbit, even in the past, seems to be not very probable. Planetary perturbations could scarcely have reduced the semi-major axis so much. More probably, the Geminids were separated from a parabolic comet by the close approach of the comet to the sun. Malzev[4] considered the possible connexion between the Geminids and the great comet of 1680. He disproved the separation by planetary perturbations. I have fully confirmed his conclusions. Nevertheless, the orbits come near each other a little behind perihelia and in close proximity to the sun; a possible connexion cannot therefore be excluded. Investigations of the age of the shower may throw more light on the subject.

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Ratio of Total to Selective Absorption

VALUES of the ratio of total photographic absorption (A) to selective absorption (E) in our galaxy have been found by several investigators. Summaries of various investigations are given by Oort[1] and van Rhijn[2]. The latter adopts a mean value of $A/E_1 = 8 \cdot 2$ (where E_1 is photo-electric colour excess). For the Andromeda nebula, Stebbins and Whitford[3] find $A/E = 4 \cdot 0$.

From an analysis of star counts, the surface distribution of obscuring clouds affecting the stars of photographic magnitude 13·0 within galactic longitudes 290–360° and galactic latitudes ± 30° has been determined. Details will be published in No. 4 of a series of "Contributions from the Armagh Observatory". By comparison with the photo-electric colour excesses of Stebbins, Huffer and Whitford[4], a value has been derived for A/E.

The mean distance of stars of photographic magnitude 13·0 was taken as 1,000 parsecs. Photo-

Star counts, rel. absorption		No. of stars with colour excess	Mean dist (parsecs)	A	E	A/E	A'/E $A' = A + 0·4$ mag	A''/E $A'' = A + 0·7$ mag	A'''/E $A''' = A + 1·0$ mag.
in log N	in m								
<0·09	<0·25	15	1004	0·15	0·14	1·1	3·9	6·1	8·2
0·09–0·18	0·25–0·50	12	982	0·39	0·23	1·7	3·4	4·7	6·0
0·18–0·36	0·50–1·00	38	1021	0·78	0·22	3·5	5·4	6·7	8·1
0·36–0·54	1·00–1·50	13	966	1·36	0·33	4·1	5·3	6·2	7·1
>0·54	>1·50	8	926	2·31	0·50	4·6	5·4	5·9	6·5
		Mean	995	0·85	0·25	3·4	5·0	6·2	7·4

electric colour excesses of stars between 800 and 1,200 parsecs were used, the distance-moduli being those of Stebbins, Huffer and Whitford[4]. Their colour excesses (E_1) were increased by 50 per cent to reduce them to the International System (E). The stars were grouped according to the degree of obscuration, as shown in the accompanying table.

Column 7 gives the first approximation of A/E. Its systematic dependence on A suggests a zero-point correction to the latter. This is not surprising, since the values of A were derived by assuming the absence of obscuring clouds for certain of the brightest Milky Way regions, and making no allowance for general absorption in these directions. The last three columns of the table give values of A/E on the assumption of a general absorption coefficient of 0·4, 0·7 and 1·0 mag. per kiloparsec respectively.

With an absorption coefficient of 0·7 mag./k.parsec, the systematic dependence of A/E on A disappears. A value of $A/E = 6$ would therefore be indicated from the present data.

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Armagh Observatory. Nov. 5.

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Effect of E-Avitaminosis on the Histiotrophic Nutrition of the Mouse Embryo

A MAMMALIAN embryo obtains its nourishment in two ways, hæmotrophically and histiotrophically. By the former is meant feeding through the placenta, the previously broken-down foodstuffs being transferred osmotically from the maternal blood-system to the embryo; the latter, on the other hand, means that nutriment is transferred, after breakdown by certain embryonic organs, to the metabolism of the embryo, by the secreting activity of the mucous membrane of the uterus.

Histiotrophic nutrition is more primitive than hæmotrophic. In the simpler placental types the nutrition of the embryo is entirely histiotrophic. As one approaches more developed placental types, hæmotrophic nutrition becomes more and more important. Histiotrophic feeding occurs, however, in combination with hæmotrophic, in all higher placental types also, at least in the earlier period of development of the embryo.

S. Pesonen showed in 1942[1] that histiotrophic nutrition plays a great part in the embryonic development of the hedgehog, and that progesterone from the corpus luteum causes the secretion of 'histiotrophe'. The chief sites of formation of histiotrophe are those parts of the mucous membrane of the uterus which lie between the embryos, and remain modified throughout pregnancy, and where thus no decidua tissue is being formed. In collaboration with Miss Kaarina Vaalanto, I have established that the mouse embryo also uses histiotrophe as its nutriment throughout pregnancy, although this mode of nutrition is not so obvious as in the hedgehog. The histiotrophe is transferred to the embryo through the decidua capsularis and yolk-sac. The secretion of histiotrophe throughout pregnancy is due to the corpus luteum remaining active during this whole period.

E-avitaminosis in a mouse results in the offspring being stillborn, in miscarriages and resorption of the embryos. Changes in the placenta seem not to be so great that they could prevent hæmotrophic feeding and so be the reason for the discontinuance of pregnancy. According to the investigations I have carried out in collaboration with Miss Elli Laine, there seems to be less histiotrophe in the uterus of pregnant E-avitaminotic mice than in that of pregnant healthy ones. It reaches its highest value, both in the E-avitaminotic and in the normal animals, on the eleventh and twelfth days. After the thirteenth day, there is very little or no histiotrophe in E-avitaminotic mice. The modification of the mucous membrane of the uterus in E-avitaminosis is also less marked than that of the endometrium of normal uteri. The epithelium, especially, of the mucous membrane is less altered. In addition, there is little secretion present in the glands.

The investigations of Miss Elli Laine have also shown that the amount of ionized iron (determined histochemically) in the uterus begins to decrease in E-avitaminotic mice before the resorption of the embryo. Just prior to the beginning of the resorption of the embryos and during this process, it appears in especially large quantities in the yolk-sac.

A fuller report of these investigations will be published later.

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Sinus Gland and Tyrosinase Activity in *Carcinus mœnas*

IT has been shown[1] that the crustacean cuticle undergoes at each moult a tanning process similar to that taking place in insects. Tyrosine and tyrosinase, which are involved in the tanning of the insect cuticle, are known to occur also in the blood of decapod Crustacea[2,3], and it is therefore of interest to discover whether as in insects there exists a neurosecretory regulatory mechanism for the control of tyrosinase activity in relation to moulting. In the blowfly larva, the oxidation of tyrosine under the influence of tyrosinase activity is modified by the low redox potential of the blood resulting from the action of a glucose dehydrogenase, itself controlled by Weismann's ring, a complex gland near the brain[4].

A study of tyrosinase activity in *Carcinus mœnas* has shown that marked variations occur in the course of the moult cycle, although the blood tyrosine remains more or less constant (0·003 per cent) at all stages. Apart from quantitative changes in the enzyme, it appears that other limiting factors are involved in the observed fluctuations in tyrosinase activity. The redox potential of the blood shows well-marked variations in the course of the moult-cycle, being low in the middle phases of the intermoult period and later rising before the onset of ecdysis to a value of + 0·330 V. In view of the regulatory influence of redox potentials on tyrosinase activity[5,6], it seemed probable that the feeble activity observed in the middle intermoult stage may be related to the low redox potential.

That this low potential is due to dehydrogenase activity is suggested by the increase in tyrosine oxidation on treatment of blood with methyl alcohol, which is known to have an inhibitory effect on dehydrogenases[6,7]. A study of the cyanide-insensitive respiration of the blood and soft parts of *Carcinus* suggests the presence of a dehydrogenase system which is most active in the middle intermoult stages and declines some time before the moult, after which it again shows a rise. The periods of rise and fall of cyanide-insensitive respiration, later referred to as dehydrogenase activity, correspond with the variations in tyrosine oxidation.

In the light of recent observations on the sinus gland of decapod Crustacea and the hormonal regulation exercised[8-12] on moulting and associated events, such as calcium resorption from the exoskeleton, changes in water content and oxidative metabolism, it was of interest to find that dehydrogenase and tyrosinase activity appear to be controlled by the sinus gland. The effect of injecting saline extracts of eye-stalks of *Carcinus mœnas* into animals in different stages of the moult-cycle is to raise dehydrogenase values and correspondingly to reduce tyrosine oxidation. Removal of the sinus glands by eye-stalk extirpation has a marked effect on the dehydrogenase system; but one which seems, however, to depend on the stage in the moult cycle in which the operation is carried out. In the hard-crab stage, the effects are well marked, resulting in an initial fall in dehydrogenase activity followed by a rise until moulting occurs. Comparison of dehydrogenase activity in normal and operated animals of the same size and stage in the moult-cycle shows in the latter a shortening of the periods of rise and fall in the dehydrogenase cycle. This corresponds with the abbreviation of the intermoult period effected by removal of the sinus gland[13,14,12]. It appears, therefore, that the sinus gland influences dehydrogenase activity as a part of the physiological system associated with moulting.

A full account of this work will be published elsewhere.

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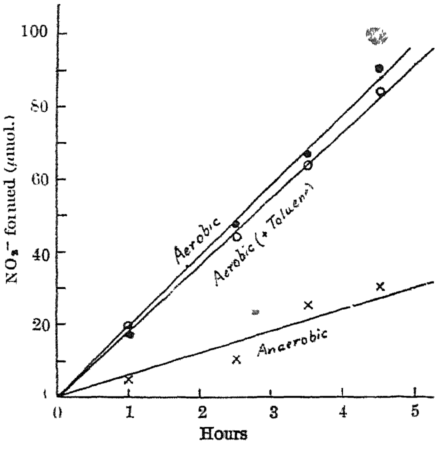
Enzymic Decomposition of Nitromethane by Liver Homogenates

Since nitro-compounds of biological origin have not long been recognized, little is known of their metabolism apart from some pharmacological investigations. Recent biochemical work, however, has revealed for the first time the presence of a nitro-group in the molecule of a microbial product, chloromycetin. Hence it is of considerable interest to study enzymic reactions involving nitro-compounds.

In the course of a study of the hepatic reduction of nitrate[1], we have observed the enzymic decomposition of nitromethane by rabbit liver homogenates to form nitrite ion as one of the products. This seems to be of significance as the first indication of the existence of an enzyme system which splits off nitro-groups from organic molecules. The present communication gives a brief report on our observations.

Fresh rabbit liver was homogenized with five volumes of distilled water in a Potter–Elvehjem homogenizer. 1-vol. portions of homogenate were incubated at 37° with 2 vol. of 0·05 *M* nitromethane in phosphate buffer (0·1 *M*, *p*H 7·4); 0·1 vol. of toluene was added occasionally to prevent contamination by bacteria, especially when incubation extended over a long period of time. The addition of toluene showed scarcely any influence upon the process. After suitable intervals the reaction mixtures were deproteinized, and the nitrite formed was determined colorimetrically with a Pulfrich stufenphotometer using Griess–Ilosvay reagent. The incubations were carried out both aerobically and anaerobically. Thunberg tubes were employed in the anaerobic experiments.

In the accompanying graph typical results thus obtained are shown. It will be seen that nitrite can be produced both in the presence and absence of oxygen, but aerobic decomposition takes place more rapidly. Nitrite formation was completely inhibited by heating the homogenates at 100° for 3 min. This fact may be considered to be evidence of the enzymic nature of the reaction. Further, it was found that the dialysis of the homogenates against standing water for 24 hr. at 1° decreased the activity to about 40 per cent of the original value, but it could be restored by the addition of boiled extracts of the liver. This seems to indicate that two components are necessary for the decomposition of nitromethane, one of which is thermolabile and colloidal, whereas the other is thermostable and of low molecular weight. No other decomposition product of nitromethane,



apart from nitrite ion, has yet been confirmed. Formaldehyde, one of the possible products, was not detected (Schiff's reagent) in the distillates of the reaction mixtures (concentrated hydrochloric acid was added to a final concentration of 20 per cent before distillation).

Heppel and Porterfield[2] have reported that rat liver homogenates can oxidize nitrite aerobically to nitrate. We have also confirmed this fact in beef liver homogenates; but the oxidation of nitrite by rabbit liver homogenates has been found to be negligible compared with the formation of nitrite from nitromethane.

Details of the experiments will be described elsewhere.

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Enzymic Inactivation of Serum Gonadotrophin

THE recent reports by Whitten[1] and Friedmann[2] that a partially purified *Clostridium welchii* culture filtrate contains one or more substances which inactivate serum gonadotrophin, and that one of the factors responsible may possibly be identified with the enzyme destroying blood-group O substance, prompts us to record some results obtained by us at the National Institute for Medical Research during 1943–45 on the action of taka-diastase upon serum and chorionic gonadotrophins.

Evans and Hauschildt[3] found preparations of serum gonadotrophin to suffer loss of activity when incubated with proteolytic or carbohydrate-splitting enzymes, including taka-diastase, and drew the conclusion that both the carbohydrate and protein portions of the molecule are essential for the activity of the hormone. They clearly assumed, without further experimental support, that the inactivating power of taka-diastase was due to its amylolytic enzyme. One of us[4] has reported the presence in taka diastase of N-acetylglucosaminidase (with optimal pH 6·5), and it seemed necessary to ascertain whether or not this enzyme could inactivate mares' serum gonadotrophin.

Crude taka-diastase, kindly supplied by Messrs. Parke Davis, was fractionated by ethanol at pH 4·8, and the units of diastase (*d*, estimated by Wohlgemuth's achromic point method, optimal pH 5·2) and of glucosaminidase (φ, estimated by liberation of phenol from β-phenyl-N-acetylglucosaminide, where 1 unit is defined as the amount of enzyme producing 50 per cent hydrolysis of 2 mgm. of substrate in 1 hr. at 37° and pH 6·5) present in each fraction determined, with the following result (Table 1). Nearly 60 per cent of the glucosaminidase activity but only 10 per cent of the diastatic activity is precipitated by 45 per cent (v/v) ethanol.

Table 1. FRACTIONATION OF CRUDE TAKA-DIASTASE BY ETHANOL AT pH 4 8

Ethanol % (v/v)	Wt. ppt. (gm.)	N-acetyl-glucosaminidase (φ) units	Diastase (*d*) units	φ/*d*
Starting material	50	2,000,000	20,000,000	0·1
0–45	8 560	1,176,000	2,000,000	0·6
45% insol *	6·3			
45–50	4·305	709,200	3,333,333	0·2
50–55	9·385	56,800	12,000,000	0·005
55–60	3·675	nil	600,000	—
60–66	3·310	nil	33,333	—
M. liq.	13·113	nil	2,500	—
Total	48·648	1,942,000	17,969,166	

* Material which did not redissolve in water: mainly inorganic

The fractions containing diastase and glucosaminidase were further purified with regard to the respective enzymes, mainly by adsorption processes, and although complete separation was not achieved, the amount of diastase still present in the glucosaminidase was reduced more than a thousandfold. Such a preparation produced no significant inactivation of serum gonadotrophin, whereas crude taka-diastase containing the same unitage brought about a 66 per cent inactivation in the same time under identical conditions (see Table 2). Glucosaminidase could therefore be excluded as a possible inactivator of mares' serum gonadotrophin. The diastase fraction, when similarly tested, brought about 19 per cent inactivation as compared with 81 per cent in the crude material. Still further purification by electrophoresis provided a very active diastase, but which was completely without action on the gonadotrophin even when tested at eighteen times the unitage and for three times the duration which sufficed for the crude material (Table 2). The enzyme responsible for the inactivation of gonadotrophin is not, therefore, the diastase. The possibility of its being a protease or simple peptidase was excluded by tests using gelatin or leucyl–glycine as substrate, and by examining for any increase in titratable carboxyl-groups during the inactivation of mares' serum gonadotrophin by taka-diastase.

An attempt to define the nature of the inactivating enzyme was next made by studying the products of its reaction with mares' serum gonadotrophin; but difficulty was encountered owing to the fact that gonadotrophin preparations had to be used that were known to be not more than 20 per cent pure. Nevertheless, it was shown that inactivation is accompanied by the liberation of some material which passes through a 6-mμ 'Gradocol' membrane in ultrafiltration, and which contains carbohydrate determinable by the orcinol or Hagedorn and Jensen methods. The quantity by either method amounted to about 6·5–7·5 per cent of the total carbohydrate of the mares' serum gonadotrophin preparation.

Table 2. INACTIVATION OF GONADOTROPHIN BY PURIFIED TAKA-DIASTASE FRACTIONS

Fraction	pH	Added to 3 3 mgm. mares' serum gonadotrophin (7,000 I U.)			% inactivation in 1 hr. at 37°
		Dry wt. (mgm)	Units (*d*)	Units (φ)	
Crude takadiastase	5·2	0·94	1,500	150	81·4
,, ,,	6·5	0·94	1,500	150	65·7
,, ,, (heated)	5·7	0·94	1,500	150	0
Diastase	5·2	0·47	1,500	4·5	18·6
Diastase (electrophoretic)	5 2	1·12	26,700	200	0 (in 3 hr.)
N-acetyl-glucosaminidase	6 5	0·23	1·25	150	1·7

The enzyme was largely inhibited by addition of certain metal co-ordinating substances, α-methyl-α-hydroxy butyrate being found most effective in this respect.

Chorionic gonadotrophin is similarly inactivated by crude taka-diastase.

A study has also been made of the action of 0·05 N sodium carbonate at 100° for 6 min.[5] upon serum and urinary gonadotrophin preparations, and upon the carbohydrate-rich fractions of normal horse serum[6]. This treatment liberated about 40 per cent of the total N-acetylglucosamine from the mares' serum and human chorionic gonadotrophins. The proportion of their N-acetylglucosamine liberated from the serum albumin fractions varies from 0 to 90 per cent, and is related to the concentration of ammonium sulphate required for their precipitation. Thus fractions precipitated by 50, 60 and 66 per cent saturation yielded 0, 64·5 and 90 per cent of their N-acetylglucosamine contents respectively. The interpretation of the reaction with impure gonadotrophin preparations is therefore difficult.

The investigations referred to in this letter are being taken up once more, and, in particular, the purification of the gonadotrophin-inactivating enzyme in taka-diastase.

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Amino-acids in Soil

ALTHOUGH the protein nature of at least one-third of the organic nitrogen of soil has been established[1,2], very little is known of the amino-acid composition of this protein material. The isolation of amino-acids from soil hydrolysates is rendered difficult by the presence of large amounts of extraneous inorganic and organic material.

The present communication gives preliminary results of an examination of the amino-acid composition of soil hydrolysates by the paper chromatography technique[3]. The soils were hydrolysed for 24 hr. with 6N-hydrochloric acid and the hydrolysates evaporated to dryness *in vacuo*, redissolved in a little distilled water, neutralized and desalted on the apparatus devised by Consden, Gordon and Martin[4]. The experimental procedure used for two-dimensional chromatography was essentially that of Dent[5], phenol and a collidine–lutidine mixture being used as solvents. The soils examined included several highly organic neutral soils from the Fens and neutral mineral soils from Rothamsted plots. The following amino-acids have been identified in the hydrolysates of these soils: aspartic and glutamic acids, serine, threonine, glycine, alanine, valine, leucine, *iso*leucine, proline, hydroxyproline, arginine, histidine, lysine, phenylalanine, tyrosine, β-alanine, α-amino-*n*-butyric acid and γ-aminobutyric acid. In addition, glucosamine and two as yet unidentified substances giving purple colours with ninhydrin have been detected. The latter occupy positions under glutamic acid and under proline on the two-dimensional chromatogram Attempts are now being made to identify these substances.

The amino-acid composition of the protein material appeared to be substantially the same over the range of soils so far examined. No free amino-acids have been detected in any of the soils studied.

Full details of this work will be published elsewhere.

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Occurrence of Pterin Pigments in Hymenoptera

IT has been found that pterins exist in tissues of animals belonging to nearly all groups; their occurrence as pigments, however, is restricted to insects and cold-blooded vertebrates[1,2]. Among Lepidoptera, they are always present in the wing-scales of the Pieridæ and appear to be a biochemical characteristic of that natural family[3,4]. Becker and Schöpf[5] and Becker[6] also found pterins in the integument of Hymenoptera and gave evidence of their wide distribution within this order.

In 1947, E. B. Ford[4] described a new 'murexide test' for the recognition of pterin pigments in the wings of intact butterflies. This consists in exposing specimens to chlorine and then fuming with ammonia. Following this treatment, pterin pigments develop a brilliant purple colour. We have applied this method successfully to the pterins of the exoskeleton of Hymenoptera.

The yellow and yellowish spots of adult Hymenoptera give the reaction. One exception only was recorded: the yellow of *Urocerus gigas* L. (Siricidæ) seems to be due to light melanin and not to pterins.

Hymenoptera show, therefore, a striking difference in that respect from Lepidoptera. Pterins are found as pigments among Symphyta, parasitic and aculeate Hymenoptera, in primitive as well as in highly specialized groups. There is scarcely any family which shows pterin pigments in all its representatives; but there are several tribes and generic entities which do so (Philanthinæ, Bembecinæ, *Crabro*, *Ectemnius*, *Lestica*, *Odynerus*, etc.). Moreover, a large number of families and genera are entirely devoid of pterin pigments (Siricidæ, Trigonalidæ, Formicidæ, Chrysididæ, Pseninæ, etc.).

Preliminary conclusions can also be drawn suggesting relationships between the occurrence of pterins in the integument and geographical and morphological features. Groups mostly distributed in the northern hemisphere often have large spots of yellow pterin pigment (Pamphiliidæ, Cephidæ, Tenthredininæ, Metopiinæ, Ichneumoninæ, Crabroninæ of the genera *Crabro*, *Ectemnius* and *Lestica*; Vespidæ of the genera *Vespa*, *Pterochilus*, *Psiloglossa*, *Celonites*, *Jugurthia* and the parasitic bees *Nomada*). On the other hand, groups mostly distributed in the southern hemisphere and in the tropical regions are often devoid of yellow spots (Arginæ, Aulacidæ, Trigonalidæ, Stephanidæ, Evaniidæ, Pelecinidæ, Trypoxyloninæ and Vespidæ of the genera *Zethus*, *Montezumia*, *Icaria*, *Polybia*, etc.). Among aculeate Hymenoptera, the genera with strongly petiolated first abdominal segment are usually without yellow spots; whereas it can be said tentatively that the Sphecidæ and Vespidæ with bright yellow spots on the abdomen should be generally referred to forms with sessile first abdominal segments.

JEAN LECLERCQ

Laboratories of Biochemistry,
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Oct. 11.

[1] Purrmann, R., *Forschr. Chem. Org. Naturstoffe*, **4**, 64 (1945).

[2] Polonovski, M., and Busnel, R. G., *Exposés annuels de Biochim. Méd.*, **6**, 175 (1946)

[3] Hopkins, F. G., *Phil. Trans. Roy. Soc.*, B, **186**, 661 (1895).

[4] Ford, E. B., *Proc. Roy Entom. Soc., London*, A, **22**, 72 and 77 (1947).

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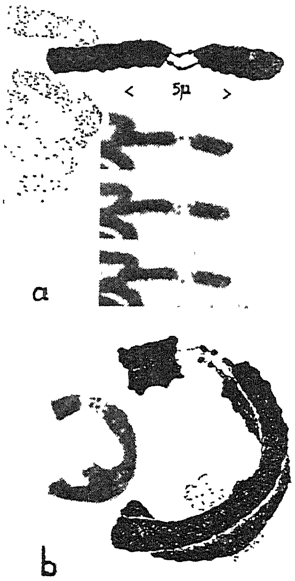
Quadruple Structure of the Centromere

PRE-TREATMENT with 8-oxyquinoline (0·002 mol. per litre for four hours) of root meristems followed by squashing in acetic orceine gives chromosome pictures of exceptional clearness. The chromosomes are contracted as after cold or c-mitotic treatment. At the same time the metaphase chromosomes remain in their original position within the equatorial plate, although the spindle does not interfere with their spreading at the squashing. Satellites and secondary constrictions are conspicuous, and help the analysis of idiograms. Prophase chromosomes often show heterochromatic differentiations. The knobs of rye chromosomes are made quite conspicuous in mitotic prophase.

The centromeric gap is unusually wide, and it often exhibits distinct centromeric chromomeres. From early prophase up to metaphase there are found four such centromeric chromomeres, generally forming a square or a parallelogram in the centromeric gap. The accompanying figures (*a*) and (*b*) show this condition in *Allium cepa* and *Scilla sibirica* respectively. At anaphase and telophase only two centromeric chromomeres are seen, their division not yet having been accomplished.



One chromosome (*a*) of *Allium cepa* (at three different foci), and (*b*) of *Scilla sibirica* (drawing and microphotograph)

The type of structure described here has been demonstrated with our technique in species of the following genera: *Tradescantia*, *Scilla*, *Lachenalia*, *Hyacinthus*, *Allium*, *Sauromatum*, *Amorphophallus*, *Hæmanthus*, *Vallota*, *Amaryllis*, *Crinum*, *Cyrtanthus*, *Nerine*, *Hordeum*, *Secale*, *Triticum*, *Triticale*, *Vicia*. There seems to be a correlation in size between the chromosomes and their centromeric bodies; thus, the centromeric chromomeres were largest in *Scilla*, smaller in *Allium* and *Hordeum*. In species with small chromosomes we have so far been unable to detect any centromeric bodies, possibly because the chromosome contraction effected in such chromosomes is too strong. Thus *Vicia faba* presented centromeric bodies, whereas *Vicia cracca* with its much smaller chromosomes did not.

The results mentioned here give a new aspect to the view of the centromeric apparatus as a structure that is doubled in the longitudinal direction, earlier demonstrated with other techniques by Östergren[1], Lima de Faria[2] and Levan[3].

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Sveriges Utsädesförening,
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Oct. 5.

[1] *Botaniska Notiser*, **176** (1947).

[2] *Hereditas*, **35**, 77 (1949).

[3] *Hereditas*, **32**, 449 (1946)

Colour-Contrast Phase Microscopy

THE possibilities of utilizing the differential chromatic effects of the Rheinberg ring method of illumination, which was later developed into the optical staining principles of Kraft[1], in conjunction with phase-contrast microscopy, suggested that, instead of having the substage stop quite blacked out except for the annulus, cross or line, whichever the case may be, this should be replaced by an appropriate colour filter, and the portion which usually transmits the light be of another colour in contrast to it.

A number of combinations have been tried with the materials available to date and the best results were secured with the following:

	Transmitting area, annulus, cross or line	Substage field filter, usually blacked out
1	Yellow	Blue
2	Yellow	Purple
3	Green (light)	Purple
4	Blue (light)	Red
	also used with success:	
5	Clear glass	Blue
6	Clear glass	Purple

The Wratten series of filters have been used, and with those available the best results obtained have been in the order given above. It is essential that all filters should have sharp absorption curves, so that too much chromatic overlapping is avoided. The image, that is the portion usually appearing black in ordinary monochromatic phase-contrast, assumes in each case the colour of the filter appearing in the second column, the phase 'halo' being that of the normal transmitting area, and the more distant portions of the clear field being of an intermediate shade. The substage 'field' portion must always be less bright visually than the transmitting area, and a valuable method of varying the intensity of the image contrast is to mount portions of 'Polaroid' over the field areas of this plate, and decrease or increase the intensity by rotating a 'Polaroid' screen in an understage filter carrier. In this case, as the crossed position was approached, the image assumed the characteristics of normal monochromatic phase-contrast, excepting that the field of view in the microscope took the colour of the transmitting portion. Further useful contrast effects may be obtained by placing an appropriate filter over the ocular of the microscope.

This method has been used with success on difficult sections of neurological material prepared by the Feulgen Light-Green technique[2] mounted in fluid or 'Euparal', and it greatly facilitates the examination of all faintly stained or coloured slides when suitably mounted. Contrast is obtained by virtue of the slight colour differences of fine detail not revealed by normal phase-contrast or ordinary light filters. The examination of insect parts is facilitated, and many applications will no doubt arise in the normal course of research.

It is a pleasure to record my indebtedness to Mr. M. G. L. Curties, of Messrs. C. Baker, London, W.C.1, whose assistance so readily given made this research possible.

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Dec. 2.

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[1] Kraft, P., *Z. deut. geol. Gesell.*, **84**, 651 (1932).

[2] Semmens, C. S., and Bhaduri, P. N., *Stain. Tech.*, **14**, 1 (1939).

Preparation of Acetobrome-Sugars

THE preparation of acetobrome-sugars involves generally the use of hydrogen bromide dissolved in glacial acetic acid or acetic anhydride. These solutions are very disagreeable to handle and to prepare; we therefore tried to circumvent their use, and after some preliminary experiments found a really satisfactory way of doing so.

We found that perchloric acid is a very efficient catalyst in acetylation[1-4], as described by several authors. We did not find it necessary, however, to use a mixture of acetic anhydride and glacial acetic acid; the method works perfectly with acetic anhydride alone. The essential feature of our procedure is to generate hydrogen bromide within the reaction mixture. To do this we either added phosphorus tribromide and water to the mixture, or simply added phosphorus, bromine and water one after the other. The minimal amounts and reaction times necessary to accomplish the reaction were determined in a series of experiments.

We prepare acetobrome-glucose as follows: 400 ml. acetic anhydride is mixed with 2·4 ml. perchloric acid, and 100 gm. glucose is added in the course of half an hour, taking care that the temperature should not rise unnecessarily above 40° C. (to avoid caramellization) or fall below 30° C. (to keep up a steady rate of reaction). 30 gm. amorphous phosphorus is added and the vessel is cooled in ice or an ice-salt mixture. We then add 180 gm. bromine gradually so as to keep the temperature below 20° C., and proceed directly to add 90 per cent of the stoichiometric amount of water, that is, 36 ml., carefully avoiding local rises of the internal temperature. This latter process takes about half an hour. The vessel is closed by a stopper and remains at room temperature for 1½–2 hr. Then 300 ml. chloroform is added and the mixture is poured into about 800 ml. ice-water and separated in a funnel. The chloroform layer occludes the rest of the phosphorus, and it is convenient to separate it at this stage by filtration. The filtered chloroform is extracted twice with an equal volume of ice water, taking care to extract the separated water twice with 30 ml. chloroform before discarding it. A final extraction with sodium bicarbonate solution in the separating funnel binds the last traces of acid and brings the pH to about 6. The yellow solution is dried with calcium chloride, adding a small amount of sodium bicarbonate, calcium carbonate or magnesium carbonate and about 5 gm. active charcoal with slight agitation. After half an hour the solution is filtered, evaporated *in vacuo* from a water-bath at 60° C. and dissolved in its own volume of dry ether, from which it crystallizes on cooling. Addition of double the volume of petrol-ether assures an improved yield. The product melts at 84° C. and is practically pure acetobrome-glucose. It may be used directly for further synthesis. Yield: 85 per cent; recrystallization from ether gives a melting point of 87° C.

We prepared the acetobrome derivatives of galactose, arabinose, lactose, cellobiose and maltose by the same method. It was necessary to use some glacial acetic acid for the acetylation of cellobiose, due to its poor solubility; and we only succeeded in obtaining a crystalline product from galactose when we dissolved the syrup in absolute ether. The syrup of brom-acetomaltose turned into a white powder on addition of ligroin (b.p. 80–100° C.) with the somewhat uncertain melting point of 78° C. instead of 84° C., but contained the theoretical percentage of bromine. Rhamnose, a sugar that is not easily acetobrominated except with titanium tetrabromide, yielded a syrup which we were not able to crystallize. Yields before recrystallizing were: lactose 85 per cent, arabinose 50 per cent, maltose 60 per cent, cellobiose 72 per cent, galactose 75 per cent.

The whole procedure is easily finished in a working day of eight hours, exclusive of recrystallization. The products are very pure and may be kept in a vacuum desiccator for weeks without decomposition. We think that the above method may be extended to similar compounds and represents the simplest way of obtaining them.

We are indebted to Prof. Z. Csűrös for permission to work in his laboratory, and are grateful to him as well as to Prof. R. Bognár for their advice. One of us (F. K.) has a grant from the Hungarian Council of Science.

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Oct. 14.

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[1] Nicholas, S. D., and Smith, F., *Nature*, **161**, 349 (1948).

[2] Krueger, D., and Roman, W., *Berichte*, **69**, 1830 (1936).

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Difference Equations of Moment-Generating Functions for some Probability Distributions

Wishart and Hirschfeld[1] obtained the moment-generating function for the probability distribution of adjacent black-white joins when m points, black or white with probabilities p and q, are arranged at random on a line, by working out the difference equations connecting the moment-generating functions for $(m-1)$, m and $(m+1)$ points. Recently, Krishna Iyer[2] used this method to derive the moment-generating function for the distribution of black-black joins. The success of the method depends upon the fact that the r-th factorial moment, $\mu'_{[r]}$, is equal to $r\,!$ multiplied by the expectation for obtaining r black-black joins. This property will enable us to work out the difference equations satisfied by the moment-generating functions of a number of distributions arising from m points arranged at random on a line. This note gives *in seriatim* the difference equations for the following distributions: (i) the number of joins between points of different colours when the points can assume one of k colours with probabilities $p_1, p_2 \ldots p_k$, (ii) the number of runs of length r of a specified colour, (iii) the number of runs of length r or more of a specified colour, and (iv) the number of triplets, quadruplets, etc., of a specified colour. They are as follow:

$$\text{(i)} \quad M_m - M_{m-1} - 2a_2\theta M_{m-2} - \sum_{r=2}^{k}(r-1)a_r\theta^r M_{m-r} = 0,$$

where a_r stands for the monomial symmetric function of degree r in $p_1, p_2, \ldots p_k$, that is, $(\Sigma\, p_1p_2 \ldots p_r)$

$$\text{(ii)} \quad M_{m+r+1} - M_{m+r} - p^rq\theta M_m + p^{r+1}q\theta M_{m-1} = 0.$$

$$\text{(iii)} \quad M_{m+r+1} - M_{m+r} - p^rq\theta M_m = 0.$$

$$\text{(iv)} \quad M_{m+1} - (1 + p\theta)\, M_m + pq\theta \sum_{r=1}^{s-1} p^{r-1} M_{m-r} = 0.$$

where s is the number of points in the s-plet.

In the above expressions, p is the probability of a point taking the specified colour, and $q = 1 - p$, while θ and M_m stand respectively for $(e^t - 1)$ and the moment-generating function for m points.

By extending the methods already used by me[2], it can be shown that the cumulants of all these distributions are linear functions in m, the number of points on the line, and therefore all these distributions tend to the normal form when m tends to infinity. Details will be published shortly in the *Journal of the Indian Society of Agricultural Statistics*.

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Sept. 23.

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[1] Wishart, J., and Hirschfeld, H. O., *J. Math. Soc., London*, **11**, 227 (1936).

[2] Krishna Iyer, P. V., *J. Ind. Soc. Agric. Stat.*, **1**, 171 (1948).

Sulphanilamide as a Preservative for Sweet Juices from Palm Trees

The sweet juices from palm trees (date, brab, coconut and sago) which grow abundantly in the tropics are collected for toddy (fermented juice) or for conversion into liquor. The fresh juice is found to contain about 10–14 per cent of sucrose and could be a useful source of sugar, thus replacing cane sugar and releasing fertile land for cereals.

Palm juice is fermented very quickly; to prevent inversion and fermentation while the juice is being collected, the usual practice is to add a small amount of lime to the pots. This lime does not prevent inversion and, later on, the juice is fermented. Work carried out at this Institute has shown that palm juice is slightly acid (pH about 6) when fresh, but it soon becomes acid (pH about 4), and then is fermented to produce toddy by airborne bacteria. Experiments have shown that the juice can remain fresh and unfermented for a few hours if it is kept alkaline (above pH 8); in order to preserve palm juice from inversion and fermentation, so as to convert it into either gur or sugar, a preservative is needed. It has been found that sulphanilamide, when added to palm juice in quantities 10–60 p.p.m. (40–250 mgm. to a gallon), preserves the juice in its fresh condition from five to twenty days.

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Oct. 8.

Rapid Estimation of Standard Deviation

A simple graphical method of calculating standard deviations has been described by Dr. B. Woolf[1]. It is sometimes useful, as a means of estimating short-term variations in a process or product, as distinct from long-term trends, to measure the root-mean-square of the differences between each reading and the next, a quantity which, in the absence of any trends, would be expected to have a value $\sqrt{2}\,\sigma$. A modification of Woolf's method enables this to be measured even more simply than the standard deviation.

As in Woolf's method, the various readings (in chronological order, A_1, A_2, etc.) are marked off on a line at one side of a piece of graph paper. With dividers a length A_2P_2 is then marked off equal to A_2A_1 on a line perpendicular to A_2A_1. Then $A_2P_2 = |\,a_1 - a_2\,|$. The point of the dividers is then moved from A_2 to A_3 and A_3P_3 is marked off perpendicular to A_1A_3 so that $A_3P_3 = A_3P_2 = \{(a_1 - a_2)^2 + (a_2 - a_3)^2\}^{1/2}$. By repetition of the process, moving the points of the dividers alternately, the square root of the sum of squares of differences can be found very rapidly.

Obviously, if the points have already been plotted on a control chart, there is no need to mark off the points A_1, etc.

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[1] *Nature*, **164**, 360 (1949).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, March 6

Royal Geographical Society (joint meeting with the Systematics Association, at 1 Kensington Gore, London, S.W.7), at 2.30 p.m.—Symposium on "The Cartographical Presentation of Biological Distributions".

British Society for the History of Science, Philosophy of Science Group (in Room A.3, Zoology Department, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Annual General Meeting.

Institution of Electrical Engineers (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "The Place of High-Frequency Heating in Industry" (to be opened by Mr. C. E. Eadon-Clarke).

Society of Engineers (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. R. E. Doré: "Oxygen and other Gases and their Application to Industry".

Institution of Electrical Engineers, Mersey and North Wales Centre (at the Liverpool Royal Institution, Colquitt Street, Liverpool), at 6.30 p.m.—Discussion on "The M.K.S. System of Units" (to be opened by Dr. E. Bradshaw).

Society of Chemical Industry, Fine Chemicals Group (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6.30 p.m.—Dr. S. T. Henderson and Dr. J. W. Strange: "Recent Developments in Fluorescent Materials".

Chemical Society, Eire Section (joint meeting with the Irish Chemical Association, the Royal Institute of Chemistry, and the Society of Chemical Industry, in the Chemical Laboratories, University College, Galway), at 7.45 p.m.—Prof. M. Stacey: "Deoxy-sugars and Nucleic Acids".

Tuesday, March 7

Chemical Society, Liverpool Section (in the Chemistry Department, The University, Liverpool), at 4.30 p.m.—Prof. Dr. Pl. A. Plattner (Zurich): "Lycomarasmin, the Chemistry of Wilting Diseases".

Institute of Fuel (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. A. E. Margolis: "District Heating in the New Towns".*

Institution of Electrical Engineers (joint meeting of the Measurements and Radio Sections, at Savoy Place, Victoria Embankment, London, W.C.2) at 5.30 p.m.—Prof. F. C. Williams and Mr. S. W. Noble: "The Fundamental Limitations of Second-Harmonic Type of Magnetic Modulator as applied to the Amplification of Small D.C. Signals"; Mr. A. G. Milnes: "A New Theory of the Magnetic Amplifier".

Manchester Geographical Society (at the Geographical Hall, 16 St. Mary's Parsonage, Manchester), at 6.30 p.m.—Rev. J. L. Wilson: "Glimpses of Malaya".

Institution of Works Managers, London Branch (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 6.45 p.m.—Mr. J. Hadland: "The Application of High-speed Photographic Techniques to Industrial Problems".

Wednesday, March 8

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Prof. M. L. Oliphant, F.R.S.: "The Industrial Applications of Atomic Energy".

Aslib (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. F. C. Francis: "The British National Bibliography"; Mr. W. Cox: "Government Publications, with Special Reference to the Card Index Service".

Physical Society, Low Temperature Group (in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 5.30 p.m.—Prof. H. Hausen (Hanover): "Heat Exchange and Rectification in Reflux Condensers".

Royal Institute of Chemistry, London and South-Eastern Counties Section (in the Zoology Lecture Theatre, The University, Reading), at 6.45 p.m.—Dr. G. W. Scott Blair: "Recent Advances in Rheology".

Chemical Society, Eire Section (in the Department of Chemistry, Trinity College, Dublin), at 7.45 p.m.—Prof. Dr. Pl. A. Plattner (Zurich): "Lycomarasmin, the Chemistry of Wilting Diseases".

Thursday, March 9

Royal Society (at Burlington House, Piccadilly, London, W.1), at 10 a.m.—Discussion on "Bond Energies and Bond Lengths" (to be opened by Prof. M. G. Evans, F.R.S.).

Linnean Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Discussion on "Time Rates in Evolution" (to be opened by Prof. F. E. Zeuner and Prof. James Small).

Royal Society of Arts, India, Pakistan and Burma Section (at John Adam Street, Adelphi, London, W.C.2), at 5.15 p.m.—Mr. E. V. Parkinson: "The Growth of the Steel Industry in India".

Institution of Electrical Engineers, Utilization Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. H. K. Bourne and Mr. E. J. G. Beeson: "The Application of Electric Discharge Lamps for Daylight Signalling".

University of London (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. B. Rensch (Münster): "Problems of Directed Evolution".*

Chemical Society, Manchester Section (in the Chemistry Department, The University, Manchester), at 6.30 p.m.—Prof. J. W. Cook, F.R.S.: "Polycyclic Aromatic Hydrocarbons".

Chemical Society, Nottingham Section (joint meeting with the University Chemical Society, in the Chemistry Lecture Theatre, The University, Nottingham), at 6.30 p.m.—Prof. W. Wardlaw: "Some Aspects of Structural Chemistry".

Royal Institute of Chemistry, London and South-Eastern Counties Section (joint meeting with the West Ham Municipal College Chemical Research Club, at the West Ham Municipal College, Romford Road, London, E.15), at 7 p.m.—Dr. F. M. Hamer: "Photographic Sensitisers".

Chemical Society, Aberdeen Section (joint meeting with the Royal Institute of Chemistry and the Society of Chemical Industry, in the Chemistry Department, Marischal College, Aberdeen), at 7.30 p.m.—Prof. H. B. Nisbet: "The Chemistry of Anæsthetics".

Institution of the Rubber Industry, Leicester Section (at the Bell Hotel, Leicester), at 7.30 p.m.—Mr. W. P. Fletcher: "Engineering with High Polymers".

Pharmaceutical Society (at 17 Bloomsbury Square, London, W.C.1), at 7.30 p.m.—Dr. J. O. Irwin: "Statistics and Biological Assay".

Friday, March 10

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

Bedson Club (in Lecture Theatre 1, Chemistry Department, King's College, Newcastle-upon-Tyne), at 5.30 p.m.—Prof. R. D. Haworth, F.R.S.: "The Natural Products of the Cycloheptane Group" (Seventy-seventh Bedson Lecture).

University of London (at King's College, Strand, London, W.C.2), at 5.30 p.m.—Prof. J. H. Taylor: "The Contribution of Petrology to the Study of Sedimentation" (Inaugural Lecture).*

University of London (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. B. Rensch: "Histological Changes correlated with Changes in Body Size" *

Institution of Electrical Engineers, Education Discussion Circle (at Savoy Place, Victoria Embankment, London, W.C.2), at 6 p.m.—Discussion on "A Demonstration Mercury-Arc Rectifier" (to be opened by Mr. A. M. Hodgson and Prof. G. F. Nicholson).

Institution of Electronics, North-Western Branch (at the Gas Showrooms, Town Hall, Manchester), at 6.30 p.m.—Mr. T. M. C. Lance: "Improvements in Large Screen Television".

Institution of Works Managers, Manchester Branch (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Mr. Philip H. Briggs: "The Application of Electronics in Industry".

Oil and Colour Chemists' Association, Manchester Section (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Mr. G. A. Campbell: 'Dispersion and Wetting in Non-Aqueous Media".

Chemical Society, Glasgow Section (joint meeting with Local Chemical Societies, in the Chemistry Department, The University, Glasgow), at 7.15 p.m.—Dr. A. H. Cook: "Purine Synthesis, a New Chapter".

Chemical Society, Northern Ireland Section (joint meeting with the Royal Institute of Chemistry and the Society of Chemical Industry, in the Agricultural Lecture Theatre, Elmwood Avenue, Belfast), at 7.30 p.m.—Mr. R. A. Wells: "Inorganic Chromatography".

Saturday, March 11

Society of Leather Trades Chemists, Manchester Group (at the Engineers' Club, Albert Square, Manchester), at 2 p.m.—Mr. J. N. Blake: "The Use of Hide Trimmings by the Gelatine Manufacturer"; Mr. Charles Higham: "Hair, its Washing and Subsequent Uses".

London County Council (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Mrs. Mercedes Mackay: "Primitive Musical Instruments of Nigeria".*

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant (with a Fuel, Engineering or Chemical Engineering degree or equivalent qualifications) to the Fuel Technologist (Ref. AE/48), and an Assistant (with a good Honours degree in Chemistry or Chemical Engineering or A.R.I.C. by examination or A.M.I.Chem.E.) to the Scientific Adviser (Ref. AE/49), in the Generation Operation Branch of the Chief Engineer's Department at headquarters in London—The Director of Establishments, British Electricity Authority, British Electricity House, Great Portland Street, London, W.1, quoting the appropriate Ref. No. (March 10).

Lecturer (Grade II) in Industrial Metallurgy—The Secretary, The University, Birmingham 3 (March 18).

Principal Scientific Officer (Ref. C.70/50A), mechanical or aero engineer with experience in aircraft structures and engineering installations, Senior Scientific Officers (Ref. A.24/50A), physicists for research with new armament test methods, including problems on bombsighting, gunsighting, gunblast and recoil, Senior Scientific Officer (Ref. C.71/50A), aero engineer with interest in helicopters for work connected with performance testing of rotary wing aircraft, Scientific Officers (Ref. A.25/50A), applied mathematicians for general analytical work to assist S.S.O. (Physicist) above, Scientific Officer (Ref. C.72/50A), mechanical or aero engineer for flight test work and investigations into engineering problems associated with high altitude flying, at Ministry of Supply Aircraft Experimental Establishments in Southern England—The Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (March 20).

Experimental Officers at Ministry of Supply Radiochemical Centre, Amersham, Bucks., for duties connected with production, processing and distribution of radioactive materials—The Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.111/50A (March 25).

Experimental Officers (2, temporary) in the Pest Infestation Laboratory, London Road, Slough (*a*, Chemist for work on the application of fumigants to stored foodstuffs; *b*, Biochemist for research on the reaction of fumigants with biological materials such as proteins, vitamins, enzymes, etc.)—The Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.122/50A (March 25).

Lecturer in Agriculture, and a Lecturer in Horticulture—The Secretary for Education, County Buildings, Shrewsbury (March 25).

Research Officer (with University degree in science with physics and/or chemistry as major subjects or equivalent qualifications) in the Chemical Physics Section, Division of Industrial Chemistry, Melbourne, to carry out research in the application of electron diffraction to structural problems—The Chief Scientific Liaison Officer, Australian Scientific Research Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 2723 (March 25).

Scientists, Grade III (with first or second class honours in physics, chemistry or engineering, or equivalent qualification) at the Central Research Establishment at Stoke Orchard, near Cheltenham—The National Coal Board, Establishments Branch (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/194 (March 27).

Demonstrator in Biochemistry and Chemistry (with particular interest and training in Physical Chemistry)—The Dean of the Medical College, St. Bartholomew's Hospital, West Smithfield, London, E.C.1 (March 31).

Demonstrator (with good honours degree in physiology, biochemistry or chemistry with subsidiary physiology) in Physiological Chemistry—The Registrar, The University, Manchester 13 (March 31).

Lecturer (Grade II) in Mechanical Engineering—The Secretary, The University, Birmingham 3 (March 31).

Scientific Officers (with good honours degree or equivalent in mathematics, physics or engineering, and experimental experience) and Experimental Officers (with at least Higher School Certificate or equivalent), at Royal Aircraft Establishment, Farnborough, for work on design and development of large wind tunnels and associated aerodynamic research equipment—The Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.30/50A (March 31).

Biochemists with special interest and experience in protein chemistry, to undertake research on plasma fractionation and to develop the large-scale production of plasma protein fractions at Edinburgh—The Secretary, Scottish National Blood Transfusion Association, 10 Duke Street, Edinburgh 1 (March 31).

Beit Fellowships for Scientific Research—The Registrar, Imperial College of Science and Technology, South Kensington, London, S.W.7 (April 1)

Experimental Officers (3, temporary) in the Mechanical Engineering Research Organisation of the Department of Scientific and Industrial Research:—Ref. D.48/50A, for the application of electronic techniques to the measurement of transient forces and small movements; Ref. C.89/50A, for basic research on the machinability of metals, Ref. C.90/50A, for the design and development of equipment and instruments for investigating the performance of and the flow conditions in models of pumping machinery, turbine plant, etc.—The Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (April 1).

Robert Blair Fellowships in Applied Science and Technology—The Education Officer (H.1/2), The County Hall, Westminster Bridge, London, S.E.1 (April 1).

Scientist, Grade I (with a University honours degree or equivalent qualification in chemistry, chemical engineering or fuel technology), on the staff of the Director-General to deal with administrative aspects of the Board's research work—The National Coal Board, Establishments Branch (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/196 (April 3).

Lecturer or Assistant Lecturer in Mathematics at the University College of the West Indies—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (April 8).

Senior Lecturer in Veterinary Pathology—The Secretary and Registrar, The University, Bristol (April 8).

Veterinary Research Officers, male (one in the Senior Scientific Officer grade for a bacteriologist with experience in the study of bovine mastitis, two in the Scientific Officer grade, one in pathology and one in bacteriology)—The Director, Agricultural Research Council Field Station, Compton, Newbury, Berks (April 11).

Assistant Keeper in Egyptology in the Manchester Museum—The Registrar, The University, Manchester 13 (April 14).

Beit Memorial Fellowships—The Secretary, Beit Memorial Fellowships for Medical Research, Lister Institute, Chelsea Bridge Road, London, S.W.1 (April 14).

Reader in Anthropology at the London School of Economics and Political Science—The Academic Registrar, University of London, Senate House, London, W.C.1 (April 14).

I.C.I. Research Fellowships in Chemistry or Physics, or some allied subject such as Biochemistry, Chemotherapy, Pharmacology, Metallurgy or Engineering—The Registrar, The University, Liverpool (April 15).

Lecturer (man or woman) in Botany (Plant Physiology), a Lecturer (resident, woman) in Chemistry, and an Assistant Lecturer (resident, woman) in Physics—The Principal, Royal Holloway College, Englefield Green, Surrey (April 15).

Lecturer in Social Psychology—The Secretary, The University, Aberdeen (April 15).

Shell Research Studentship for research in Chemical Engineering—The Shell Professor of Chemical Engineering, Department of Chemical Engineering, Tennis Court Road, Cambridge (April 18).

Professor of Agriculture at the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (April 29).

Harry Bolus Chair of Botany, and a Senior Lecturer in Geology, in the University of Cape Town—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (April 30).

International Wool Secretariat Research Scholarships—The Registrar, The University, Manchester 13 (April 30).

Lecturer in Mathematics (with special reference to the field of statistics) at the University of Malaya—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (April 30).

Research Fellow (qualified to undertake theoretical work relating to electromagnetic waves in low pressure electrical discharges and to solar and cosmic noise) in the School of Physics—The Registrar, University of Sydney, Sydney, N.S.W., Australia (April 30).

Coats Fellowship for research in Chemistry or Physics (excluding nuclear physics)—The Clerk of Senate, The University, Glasgow, W.2 (May 31).

Assistant Works Manager (with an honours degree in chemistry or Associateship of the R.I.C. or equivalent qualifications) in the Ministry of Supply Division of Atomic Energy (Production), Springfields Factory, Salwick, near Preston, to be responsible to the Works Manager for the operation of the plant in a large chemical factory—The Administration Branch, Division of Atomic Energy (Production), Risley, near Warrington, Lancs.

Mechanical or Electrical Engineers as Inspectors of Machinery in the Mines Department, Gold Coast Colony—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27099/21.

Physiological Chemist to undertake work particularly in the field of ruminant digestion—The Secretary, Rowett Research Institute, Bucksburn, Aberdeenshire.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

British Standard 1427 : 1949, Tests for Water used in Steam Generation, Group A, Control Tests for which no Laboratory is Required. Pp. 80. 7*s.* 6*d.* net. Addendum No. 1 : 1949 to British Standard 350 : 1944, Conversion Factors and Tables Pp. 27. 2*s.* net. (London: British Standards Institution, 1949.) [1212

Department of Scientific and Industrial Research: Forest Products Research. Bulletin No. 23: Flooring Softwoods, their Wear and Anatomical Structure. By F. H. Armstrong. Pp. 4+7 plates. (London: H.M. Stationery Office, 1949.) 9*d.* net. [1312

Science in Industry. Bulletin No. 4 (New Series): Technical Knowledge as an Exportable Commodity. Pp. 22. (London: Murray, Bull and Co., Ltd., 1949.) [13

Ministry of Agriculture and Fisheries. Technical Bulletin No. Laboratory Methods for Work with Plant and Soil Nematodes. Dr. T. Goodey. Pp. 20+4 plates. (London: H.M. Stationery Offi 1949.) 9*d.* net. [1312

History of the Berwickshire Naturalists' Club. Vol. 31, Part 2. Pp. iv+65–179+plates 8–13. (Lauder: H. H. Cowan, Secretary, The Roan, 1949.) 10*s.*; to Members, 7*s.* 6*d.* [1412

Wellcome Historical Medical Museum. Catalogue of an Exhibition of Books, Manuscripts and Relics commemorating the Bicentenary of Edward Jenner, 17 May 1749–26 Jan. 1823. (Published for the Trustees, the Wellcome Historical Museum.) Pp. 36+2 plates. (London: Oxford University Press, 1949.) 2*s.* net. [1412

British Flowering Plants and Modern Systematic Methods. Being the Report of the Conference on the Study of Critical British Groups arranged in April 1948 by the Botanical Society of the British Isles. Edited by A. J. Wilmott. Pp. 102. (London: Botanical Society of the British Isles, c/o British Museum (Natural History), 1949.) 10*s.* [1

Department of Scientific and Industrial Research. Report o Geological Survey Board for the Year 1948. Pp. ii+18. (Lond H.M. Stationery Office, 1949.) 6*d.* net. [1

Other Countries

Sitzungsberichte der Deutschen Akademie der Wissenschaften zu Berlin, Mathematisch-naturwissenschaftliche Klasse. Jahrgang 1948, Nr. 7: Die Ableitung der Eigenbewegungen von Sternen der AG-Kataloge mit Benutzung der Photographischen Himmelskarte, insbesondere in der Zone +20° bis 25° (Berlin B). Von O. Heckmann, W. Dieckvoss und H. Kox. Pp. 32. 2.65 D. marks. Jahrgang 1949, Nr. 1: Ein neuer Erhaltungs-Satz der Hydrodynamik. Von Hans Ertel und Carl-Gustav Rossby. Pp. 11. 1.50 D. marks. (Berlin: Akademie-Verlag, 1949.) [1312

Parliament of the Commonwealth of Australia. Twenty-second Annual Report of the Council for Scientific and Industrial Research for the Year ended 30th June 1948. Pp. 141. (Canberra: Commonwealth Government Printer, 1949.) 8*s.* [1312

Bureau des Longitudes. Annuaire pour l'an 1950. Pp. viii+604+A15+B86+C61. (Paris: Libr. Gauthier-Villars, 1950.) [1312

New Zealand: State Forest Service. Annual Report of the Dire of Forestry for the Year ended 31st March 1949. Pp. 86. (Welling Government Printer, 1949.) 1*s.* 9*d.* [1412

Academie Royale de Belgique, Classe des Sciences. Mémoires, Tome 31, Fasc. 4: Introduction a l'electrodynamique des conducteurs en mouvement. Par Prof. Jean Bosquet. Pp. 85. (Bruxelles: Academie Royale de Belgique, 1948.) 60 francs. [1412

Illinois Natural History Survey. Bulletin, Vol. 25, Article 2: Effect of Permanent Flooding in a River-Bottom Timber Area. By Le E. Yeager. Pp. 29–66. (Urbana: Illinois Natural History Survey, 1949.) [1512

University of California Publications in Zoology. Vol. 48, No. 6 Speciation in Salamanders of the Plethodontid Genus *Ensatina*. By Robert C. Stebbins. Pp. v+377–526 (plates 11–16). (Berkeley and Los Angeles: University of California Press; London: Cambridge University Press, 1949.) 2.50 dollars. [151

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RESEARCH AND INTELLECTUAL ADVENTURE

IT is one of the paradoxes of to-day that, while science is now recognized as necessary to human welfare and national survival, and much more thought is given both in industry and in government service to the conditions under which scientific research can be most fruitfully pursued, limitations on the freedom of the scientific man to follow his own bent and to publish and discuss his work freely are increasingly encountered. Even those who reject the more extravagant claims for planning and organising research have seldom, however, examined in any detail the effect of planning on the conduct of research or considered how far planning is compatible with the intellectual adventures of the individual from which the important discoveries in scientific research have come. It is, indeed, recognized that great scientific discoveries usually evade direction and organisation as surely as does the creation of great music or poetry, or sculpture or art. Some voices have indeed been raised in favour of giving the man of science his equipment and his broad problem, and leaving him alone to find the solution; and the bearing of age on creativeness has been discussed in a series of papers, by Prof. H. C. Lehman, on man's most creative years.

A more fundamental examination of the problem has been attempted by Dr. F. W. Bronk in his Benjamin Franklin Lectures at the University of Pennsylvania and published last year under the title "Changing Patterns in American Civilisation". Dr. Bronk recognizes that, besides this aspect of intellectual adventure, men of science have a second purpose, even more difficult to achieve, namely, the desire to bring order out of chaos. To grasp suddenly the relation of previously unrelated facts and thus to see their relevance is to experience a deep æsthetic satisfaction, t[illegible], quoted by F. R. Japp in his Kekulé Memorial Lecture, in which Kekulé describes the origin of his *Structurtheorie* and benzene theory, are a well-known testimony. It is in this phase of scientific endeavour that facts and observations are formed into the structure of knowledge which is the foundation for further discoveries. This, as Dr. Bronk observes, is the role of the scientific worker's creative imagination; without freedom and leisure for the play of his imagination, he becomes only a fact-gatherer, dealing with the bare bones of science, unarticulated and unclothed with the flesh of meaning. We must in our planning preserve an environment in which this freedom will be nurtured, whatever the pressure of immediate needs. It is unlikely that the imagination of the man of science will often leap to a specified goal; or that a chaos of facts will similarly fall into an ordered, predetermined pattern useful for a certain end.

Society will therefore gain most from scientific workers, Dr. Bronk observes, if they are given freedom to observe, to experiment and to think; and scientific research must be respected not only as one of the great adventures of the human mind, but also as an expression of creative imagination, which is nurtured and flourishes under much the same conditions as great art and literature and other cultural activity. It follows from this that it is well at times to look upon the process of scientific investigation not as a thing apart but as one of the creative imaginative processes to which mankind owes so much in many fields. If we understood more fully the similarity between the imaginative processes of poet and man of science, for example, we should see more clearly the dangers inherent in the planning and control of research.

This point was well brought out by Mrs. Jacquetta Hawkes in a recent talk on her father, the late Sir Frederick Gowland Hopkins, and scientific imagination, broadcast in the B.B.C. third programme. Her father, she suggested, owed some of his genius to the poet's imagination which he shared with his cousin Gerard Manley Hopkins, the poet, and that, like a poet, Gowland Hopkins possessed a private world, the coherence of which enabled him to see as a glorious whole facts which others saw only as fragments. She quotes as illustration Sir Charles Sherrington's recollection of an occasion when speaking quietly to a small audience in a gaunt lecture room, Gowland Hopkins conjured up a convincing picture of the living cell. "As I listened," said Sir Charles, "I felt I was privileged for the time to see something of the microcosmic world in which my friend's scientific thought took shape and did his bidding." Such a world is, of course, created by a personal imagination, and such thinking demands, as Sir Charles commented, "a peculiar intensity of visual imagination"—words which recall Dr. Edith Sitwell's recent comment on Gerard Manley Hopkins's "acute and piercing visual apprehension". But Mrs. Hawkes did not simply stress this revelation of the unity of the human mind. She made also the practical point that the very strong reasons for the direction of resea[illegible] to remember the int[illegible]ype of scientific worker, the original genius, who can open new roads for others to widen and extend. Such a man may be as easily stultified as any artist, and her comparison of this type of mind to a sea-anemone with its tentacles of perception outspread in the water is appropriate; a clumsy intrusion and the anemone closes. Just such a withdrawal may be caused in this type of mind by quite a slight sense of supervision or direction from outside.

Considerations of this order indicate the real danger to science, both in the planning of research and the clearance regulations for Atomic Energy Commission fellowships in the United States, with which the American Association for the Advancement of Science has recently been so concerned. This sensitiveness cannot be disregarded, although it is most pronounced in only a minority of the most creative workers. Nevertheless, it is worth while pursuing further the study of the working of the scientific imagination, and there is an interesting sentence which Mrs. Hawkes quoted from an attempt of her father to describe to her his method of thought. Describing how on a moth-hunting expedition in Kew Gardens he found a purple underwing, he said "I become conscious of something strange in my experience, it takes shape and I am able to capture it".

This parable of the way in which Gowland Hopkins said his mind had always worked will at once recall the study in the ways of the imagination which J. L. Lowes published in 1927 under the title "The Road to Xanadu". Here again is the deep well in which goes on the same incessant activity of combination and amalgamation, and the shaping spirit which achieves the magical synthesis out of chaos. Dr. Lowes was dealing with the poet's mind, but he noted how in "Science et Methode" H. Poincaré had already postulated, on the basis of personal experience, a similar activity in the mind of the man of science, and described the essential part which the unconscious mind plays in mathematical discovery and the relation of that unconscious element to conscious intellectual activities before and after.

Dr. Lowes quotes one sentence from Poincaré which recalls an observation of Sir J. J. Thomson. Poincaré wrote: "This unconscious work . . . is not possible, or in any case not fruitful, unless it is first preceded and then followed by a period of conscious work". Sir J. J. Thomson observed in his presidential address to Section A at the centenary meeting of the British Association: "I think it helps one to get new ideas if the mind does not dwell too long on one's subject without interruption, and if now and then the thread of one's thought is broken. It is, I think, a general experience that new ideas about a subject come when one is not thinking about it." Later, in "Recollections and Reflections", he added: "though one must have thought about it a good deal before", and continued: "It is remarkable that when ideas come in this way they carry conviction with them and depose without a struggle ideas which previously had seemed not unsatisfactory".

What Dr. Lowes insists on is, however, not merely that the poetic imagination has much in common with the scientific imagination, that both work on facts and not in a vacuum, that the products of both are transmuted facts, but also that imagination works its wonders through the exercise, in the main, of normal and intelligible powers. The operations he traces in his study of Coleridge's mind are, he suggests, in essentials, the stuff of general experience. Creative genius works through processes which are common to our kind, but these processes are superlatively enhanced. The "deep well of unconscious cerebration" underlies the consciousness of us all; but for genius its waters are possessed of a peculiar potency. The faculty which conceives and executes operates with sovereign power; and, for genius of the highest order, with imagination curbing and guiding the clustering associations which throng up from the nether depths of consciousness, it is controlled by a will which serves as a vision, seeing in chaos the potentiality of form, whether of poetic beauty or the unfolding conception of an ordered universe into which the immense confusion of phenomena is drawn.

The "Road to Xanadu", as Lowes traces it, is thus the road of the human spirit and imagination voyaging through chaos and reducing it to clarity and order; and it is, as he says, the symbol of all the quests which lend glory to our dust. The long, slow storing of the well; the flash of amazing vision through fortuitous suggestion; the exacting task of translating the vision into actuality: it is not for nothing that they are paralleled in the experience of Poincaré or Gowland Hopkins, and it is worth looking at them again from the particular point of view of the man of science in his method of approach to the tasks ahead.

Poincaré himself seeks the explanation of this sudden illumination in that period of preliminary conscious work which always precedes all fruitful unconscious work. He rejects the idea of pure chance, and suggests rather that the future elements of our combinations may be regarded as something resembling Epicurus's hooked atoms, the mutual collisions of which during a period of apparent repose but of unconscious work may produce new combinations and provide fresh points of departure for our calculations. Poincaré's emphasis lies not merely on this inspiration but equally on the second and following period of conscious work, with its demand for discipline, attention, will and consequently consciousness.

It is interesting to compare this view with some remarks which Sir Henry Dale made two years ago in an address on "Accident and Opportunism in Medical Research". Sir Henry suggests that it may be one of the most important qualifications for success in research that a man should know by the sub-conscious reasoning which we call instinctive judgment whether what appears to be an accident—a phenomenon presenting itself quite unexpectedly—is just a nuisance, the result of some trivial error, so that the further study of it will lead to nothing but waste of time and energy, or whether, on the other hand, it offers a possible clue to a new discovery of real importance which ought to be followed even at the cost, perhaps, of a diversion from the original objective.

The vital factor is, in fact, the alert and responsive mind, able to recognize and profit by accidents, and Sir Henry does not suggest that accident is the principal factor in research of any type. Accidents of the type he reviews in this address do not, in fact, as he says, happen to the merely fanciful speculator who waits on chance to provide him with inspiration. They come rather to him who, while continuously busy with the work of research, does not close his attention to matters outside this principal aim and immediate objective, but keeps it alert to what unexpected observation may have to offer. "I certainly do not believe," said Sir Henry, "that any research work of permanent value is done, or any discovery of importance soundly established, without a great deal of hard, systematic, and conscientious work."

Those words echo Sir J. J. Thomson's conclusion, and although Sir Henry does not comment on the discontinuity which Dr. Lowes and Sir J. J. Thomson emphasize, his words recall one observation which Dr. Lowes makes on Coleridge, namely, that Coleridge not only read books with minute attention, but he also habitually passed from any given book he read to the books to which that book referred. The well must be filled assiduously and diligently, and if it is also important that there should be a balance between accumulated knowledge of the art and quick insight unhampered by experience, we may perhaps see here a clue to the real way in which the age factor operates.

Experience clearly tends to deepen the well, and if it is the unconscious mind uninhibited by preconceived ideas that stirs the waters and brings about the new combinations of images from which issue the new conceptions and the flash of genius, we may find a clue to the influence of age and the tendency for creativeness to be greatest in earlier rather than in later years in the well-known weakening of the conscious memory with advancing years. Resilience and alertness, after all, are characteristics of the youthful mind; but youth does not have a monopoly in these qualities, as the work of many a senior investigator has shown.

Even so, generalization is unwise. Inventiveness is not necessarily the same as creativeness, as Liebman is inclined to assume; and the subconscious stripping of the film of memory and the stirring of the images in the deep well may not be identical with the deliberate reconstruction process which comes with increasing difficulty to older minds. Experience and judgment as well as youth must have their place in the research team and among our independent creative workers if mankind is to draw the fullest benefits from the scientific effort of our time. Nor should we forget the warning of the neurologist, C. J. Herrick, against ignoring the troublesome personal ingredients in original scientific investigation. For all the bias they bring, personal attitudes, interests and preconceptions are key factors and may shape the whole course of the investigation. To neglect these components of scientific work and the satisfactions of a successful outcome is, as Herrick says, to sterilize both the process and the results of the inquiry by throwing into the discard the vital germ of untrammelled imaginative thinking.

The universality and spontaneity of the imaginative process, not the age at which the mind is most creative, are the vital factors. Accordingly the main problem for us is to determine and to ensure and safeguard the conditions for creative work in which the mind has free play. No doubt it would be interesting to study the ways of the scientific notebooks, writings and reading of some of our scientific geniuses, of men of the calibre of Gowland Hopkins, in the way in which Dr. Lowes has re-traced the obliterated vestiges of Coleridge's creation. But its value would depend largely upon our ability to use such a revelation or reconstruction to explain to the society in which we live exactly why the preservation of freedom of investigation, of thought and of utterance is a condition for the continuance not only of science but also of culture in general and the great tradition which Western civilization has inherited.

CAMBRIDGE MONOGRAPHS ON PHYSICS

Cambridge Monographs on Physics
(1) Excited States of Nuclei. By Prof. S. Devons. Pp. ix+152. (2) Surface Tension and the Spreading of Liquids. By Dr. R. S. Burdon. Pp. xiv+92. (3) Oscillations of the Earth's Atmosphere. By Dr. M. V. Wilkes. Pp. ix+76. (4) Adsorption of Gases on Solids. By A. R. Miller. Pp. ix+133. (5) Some Recent Researches in Solar Physics. By F. Hoyle. Pp. xi+134. (Cambridge: At the University Press, 1949.) 12*s.* 6*d.* net each.

FOR about a decade we have been starved of British books—especially British scientific books—and it is surely a matter for some gentle rejoicing that a positive spate of five "Cambridge Monographs on Physics" has burst upon us.

Every physicist who attempts to keep abreast of his time knows the practical impossibility of doing so without such help as is given, and can only be given, by such masterpieces of compression as these volumes afford. The editors are to be congratulated on persuading five such authorities as R. S. Burdon, S. Devons, F. Hoyle, A. R. Miller and M. V. Wilkes to write on the subjects of their special interests. The price, 12*s.* 6*d.*, seems to my tax-burdened self a little stiff; but I am bound to admit that the value is good.

I felt myself a certain difficulty in reading some of the chapters—understandable in view of the compressed style inevitably used—and I venture to suggest that short introductions or summaries at the beginning or end of each chapter would prove a most helpful and useful feature. This is quite usual in original papers, and it certainly is a valuable help. There is no need to say that the printing is uniformly good.

Let us have more and more of these Monographs, even if the editors carry out their welcome threat of giving a lot of attention to nuclear physics.

R. WHIDDINGTON

(1) In his book "Excited States of Nuclei", Prof. S. Devons successfully attempts to give an account of our present knowledge of nuclear levels (up to 1948). A review of this kind can be, of course, by no means final. Experimental evidence is still mounting and is guided only little by theory. Prof. Devons adopts a very justifiable course: he sets out on a phenomenological description of the results of study and succeeds in classifying and presenting them on less than 150 pages.

Although there is no sharp dividing line, the author finds it convenient to collect information about nuclear levels in two groups: those corresponding to bound states and those to virtual states. A further chapter deals with radiative transitions. In these chapters is contained a most thorough discussion of nuclear states. Theoretical results are presented here only as far as they are pertinent, but in a further chapter Prof. Devons investigates in more detail the applicability of the various theories to the interpretation of nuclear spectra, and in particular the work of Wigner and his school, as well as the fit of the various models.

The scope of this book does not allow of description of experimental technique, though neutron spectrometry is singled out by a rather more favourable treatment. Nor is there space to state more than results only of theoretical methods; yet it would be useful here to mention more names and to give more references, and Frenkel's name should not be omitted when describing the statistical method.

An author's index in the next edition would be welcomed by readers of this book, which every student of nuclear physics will be pleased to possess.

E. W. KELLERMANN

(2) Surface tension has been of interest to the physicist in the past mainly because it is one of the few large-scale manifestations of the existence of intermolecular forces. However, owing to difficulties in experimental technique and to complexities in theory, the information obtained from a study of surface tension has been, on the whole, disappointing, and our present knowledge of intermolecular forces has been largely obtained from other sources.

To the physical chemist and the chemical engineer, on the other hand, the allied phenomena of spreading of liquids on other liquids and solids, the formation of monolayers, the flotation of minerals, and so on, have been of great advantage, and it is on these topics that the larger and more successful part of Dr. R. S. Burdon's monograph is concerned. His account of experimental work on spreading and flotation (chapters 4–7) is an admirable summary of the extensive and scattered literature on these subjects. Chapters 2 and 3, on "Measurement of Surface Tension" and "The Surface of Liquid Metals", are also very good accounts of available experimental methods in a formidably difficult field.

Chapter 1, on "The Nature of Surface Forces", is not quite so satisfactory; one might surely expect a more thorough discussion of fundamentals than Dr. Burdon provides. The notion of surface energy is admittedly more convenient than the original concept of surface tension; but it is meaningless to deny the existence of surface tension, as is done in §1.

The physical background of the subject should be given a little more weight in a monograph of this kind. A further valuable improvement would be either a collected list of references at the end of each chapter or an author index.

M. M. NICOLSON

(3) It has been known since the eighteenth century that the daily variation in the barometric pressure at sea-level is principally semi-diurnal in character, and it was pointed out by Kelvin in 1882 that this phenomenon could be explained if the atmosphere has a free oscillation of period about twelve hours, so that the semi-diurnal tide exerted by the sun is magnified by resonance. Kelvin's suggestion is the origin of the 'resonance theory' with which Dr. M. V. Wilkes's book, "Oscillations of the Earth's Atmosphere", is largely concerned. Since Kelvin's time, many attempts have been made to determine the periods of free oscillation of the atmosphere; but the existence of a twelve-hour period was only proved in 1937, when Pekeris extended the theory outlined by G. I. Taylor in 1936. Since then, Dr. Wilkes, in collaboration with K. Weekes and with the mechanical assistance of the Cambridge differential analyser, has considered the problem further and has succeeded in firmly establishing the resonance theory.

The present book describes in detail the mathematical formulation of the problem of oscillations excited by gravitational action in a rotating atmosphere (Chapter 2) and the methods by which the resulting equations may be solved (Chapter 3). A very helpful physical interpretation of the mathe matical theory is then given (Chapter 4), and finally (Chapter 5) there is a full discussion of the extent to which experimental facts may be explained by means of the theory developed in the preceding chapters. The first chapter gives a general introduction to the subject by reviewing the experimental data and historical development.

The book is well arranged and illustrated, and will undoubtedly prove most valuable to all who are concerned with atmospheric phenomena.

P. Nicolson

(4) The monograph, "The Adsorption of Gases on Solids", is a sequel to that entitled "Some Problems in Adsorption", by the late J. K. Roberts, which was published in 1939. Since then, statistical theories relevant to adsorption problems have been widely investigated and developed, necessitating a complete revision of Roberts's "Tract" in order to bring it up to date. This has been well done by the present author.

Starting with a survey of the experimental methods, the beautiful experiments of Roberts upon accommodation coefficients and the adsorption of hydrogen upon tungsten are summarized, and Knudsen's theory of accommodation coefficients developed. The following two chapters discuss the theory of adsorption of heat for mobile and immobile films. In the first of these the Langmuir adsorption isotherm is introduced, and the theory of adsorption of heat with fixed interaction between two particles adsorbed on neighbouring sites is developed. The variation of potential energy over the surface necessitates a modification of this simple hypothesis, and this is discussed in the next chapter where the results for different inverse power laws of interaction are compared with those given by the simpler theory. In the succeeding chapters the process of the formation of adsorbed films, evaporation processes and other types of adsorption are considered. The final chapter deals with dipole interactions and the modifications to adsorption processes to which these attractive forces give rise.

The book is well produced with adequate references and index. It will be of great interest to many not directly concerned with work in this subject.

F. E. Hoare

(5) Solar physics comprises: (i) experimental technique, (ii) solar observations, (iii) their translation, mainly by spectral analysis, into knowledge of the state of matter on the sun, and (iv) theories of 'why' this state obtains. This book by F. Hoyle deals with (iii) and (iv). Chapters 1 and 2 are surveys of the main phenomena (sunspots, chromosphere and corona, prominences and flares); the electromagnetic aspects, especially of solar cycles and flare conditions, are discussed further in Chapter 5. In Chapters 3 and 4 the 'why' of chromosphere and corona is explained on the hypothesis of accretion of interstellar matter. A good case is made out, although the argument is involved and the auxiliary assumptions deserve fuller discussion. (A confusing slip in the crucial equation, 15.3, appears also in the original paper (*Mon. Not. Roy. Astro. Soc.*, **107**, **184**; 1947) of Bondi, Hoyle and Lyttleton.) Solar accretion plays a part in the remaining chapters—6 (terrestrial atmospheric effects) and 7 (radio emission)—and especially in an appendix on the origin of the solar magnetic field. The general field (ascribed to an ancient rich accretion) is taken to be of the order of fifty gauss. If, as is now suspected, the general field is much smaller, some arguments in the book presumably require further examination.

The monograph is too brief for the material it has to cover, and the chapters begin and end too abruptly, without introductions or conclusions. The content of the book merits—and requires—close study.

N. B. Slater

WILD FLOWERS OF AMERICA

American Wild Flowers

By Dr. Harold N. Moldenke. (The New Illustrated Naturalist.) Pp. xxv+453+64 plates. (New York: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1949.) 52*s*. 6*d*. net.

THIS work treats in a popular manner a selection of the wild flowers of Canada and the United States. The total flora of that area has been estimated as comprising some thirty-two thousand species of flowering plants alone, so that a single volume which is not a mere catalogue of names could not do more than describe a small proportion of the whole. The selection here adopted has been, first, a restriction to the herbaceous species and, secondly, to those which are regarded as being most conspicuous or most interesting, criteria that are calculated to encompass most of the wild flowers that the casual visitor or the tourist is likely to notice. Actually, more than two thousand kinds are mentioned, and, of these, eighty-eight species are portrayed by reproductions of photographs in colour and seventy are represented in black-and-white. Mostly these species are shown as they occur in their natural environments, which adds materially to the charm and value of the illustrations. The descriptions are grouped according to the taxonomic relationships and vary greatly in respect to the amount and type of information provided.

The drawback to any work which is concerned with a selection only of a flora or fauna is the unhappy feeling that the plant or animal about which the reader may wish to learn something, if only its name, happens to be one of those that are omitted. Such selective works, if they are to avoid any sense of frustration, should therefore aim at providing diagnostic characters that are unequivocal. Here we find, for example, that of the thirty species of American aquilegias eighteen are mentioned but are characterized in the main by their colour differences and geographical provenance. Again, in the large genus *Aster*, of which some two hundred species are North American, twenty-five are here cited in varying degrees of adequacy that not a few readers may find unsatisfying.

Nevertheless, though the text is often a poor guide to identity, unless we are concerned with one of the species so admirably illustrated, the reader's attention is often drawn to features of interest such as the two types of flower borne by the milkwort *Polygala polygama*, of which some are showy and purple, others inconspicuous and borne on the horizontal underground branches; or, as other examples, we may mention the spread of *Erythronium* by its droppers and the three types of flower in the pickerel weeds (*Pontederia*). But the miscellaneous information provided must not always be taken too seriously. Thus the remarkable inflorescence of the 'obedient plant' (*Dracocephalum virginianum*) is here stated to owe its popular name to the behaviour of the flowers which when displaced quickly return as though beckoned. In actual fact, the name is due to the flowers remaining in the position to which they are moved, indicative of a most unusual organisation in the region of attachment. Normally the flowers form four equally spaced vertical series ; but one can displace them laterally at will and the flowers, at least for a time, 'stay put'.

This work is one indeed that will be cherished mainly for its illustrations, which are mostly of a high order of excellence. E. J. Salisbury

MOSQUITO ECOLOGY

The Natural History of Mosquitoes

By Marston Bates. Pp. xv+379+16 plates. (New York : The Macmillan Company ; London : Macmillan and Co., Ltd., 1949.) 37*s*. 6*d*. net.

It is a commonplace in biology that we know so much more about the ecology of animals when they are of economic importance. It was the enormous economic importance of the mosquitoes which led, thirty-five years ago, to the publication by Howard, Dyar and Knab of their monumental work on the mosquitoes of the Americas. Since that time there has been no such detailed review of existing knowledge on the general biology of mosquitoes. But a mass of fact and hypothesis has accumulated in the literature. The appearance of a really full "Natural History of Mosquitoes" by Dr. Marston Bates is therefore most welcome.

No one man can hope to have seen for himself all the complexities of mosquito life in all parts of the globe ; but his work for the Rockefeller Foundation has taken Dr. Bates to Albania and Macedonia, to Egypt, the West Indies, Central America and Colombia, so that his readings of the literature are enlivened by original observations in widely varied environments. His book was written in the course of his day-to-day work at a remote station in South America ; but any gaps (and they are not many) in his survey of the literature which this has made inevitable are more than compensated by the contact with the living mosquito in the jungle that can be felt throughout his writing.

One of the author's chief objects is to make knowledge of the behaviour of mosquitoes more readily available to students of general biological theory ; but his well-balanced and scientific treatment of all aspects of mosquito ecology in all stages of their development, including their relation to the spread of disease, their distribution and the principles of their classification, will be of even greater value to students of mosquitoes themselves.

The discussion on the problems of species formation and biological races in the mosquitoes, and the opinions expressed on mosquito taxonomy and systematics, are as wise as they are interesting. While Dr. Bates rightly urges that this field of knowledge would benefit enormously if it were more often cultivated by the professional biologist, undisturbed by the distractions of the public-health department, yet he is a trifle unsympathetic towards the efforts of the physiologists, for example, to define the mechanisms of orientation ; and he is inclined to dismiss as obscurantist jargon what is, in fact, a real contribution to understanding. He makes a plea for the use of the old word 'tropism'—an excellent word in itself, but one which has been used in so many senses that, undefined, it means just nothing. He remarks that the location of a host by mosquitoes from a distance is entirely unexplained. But the visual orientation of mosquitoes in a wind as described by Kennedy (though not quoted in this book), coupled with a klinokinetic response to warm, humid and odorous air, will provide an entirely reasonable mechanism which could well be subjected to experimental test. It is the mechanism by which the Lasiocampid moth locates its mate a mile or so upwind. All that merely serves to show how right the author is in aiming at persuading the biologist to study the mosquito.

The book concludes with a useful chapter on techniques used in the study of mosquitoes, and a long selected bibliography of works published since 1913. It is well written and agreeably printed and produced. V. B. Wigglesworth

SOCIAL STRATA IN A MID-WEST TOWN

Elmtown's Youth

The Impact of Social Classes on Adolescents. By Prof. August B. Hollingshead. Pp. xi+480. (New York : John Wiley and Sons, Inc. ; London : Chapman and Hall, Ltd., 1949.) 30*s*. net.

It is significant that at present, when some people believe English social classes to be deliquescing, there is increased study of them, both here and in the United States, where occasionally wishful thinking causes them to be regarded as insignificant.

The dust-cover of this book asserts that "class system" has an ugly sound ; but it can have even uglier results. The book is by an associate professor of sociology at Yale University and his wife, who studied the impact of class-consciousness upon 753 adolescents belonging to 535 different families in "Elmtown"—a fictitious name for a small Mid-Western community—immediately before the effects of the Second World War were apparent locally. It expresses an attitude relatively new among sociologists, "who hitherto have almost ignored the subject"—that an adolescent's "storm and stress" arise less from "genes and hormones" than from the way in which a community regards his or her manner of growing up in it.

A thorough investigation, using many methods, especially interview-techniques, was made. People long resident in the community were used as judges of their fellows' prestige, status or class-position. They agreed that in this town there were five strata, though occasionally assigning a wife to one stratum and her husband to another.

The adolescents said "There are not supposed to be any classes, but there are". An impressive finding was that the youth-training institutes were essentially negative in their aims, deliberately segregating adolescents from the real world. Often this was overt, for example, in the Lutheran Church's provision of counter-attentions to the high-school dance. The social stratification of the religious sects and of the complicated technique of 'dating' are especially interesting to British readers, who would like to see a similar investigation of a British town of comparable size. T. H. Pear

NEW EVIDENCE ON THE ANTIQUITY OF PILTDOWN MAN

By Dr. KENNETH P. OAKLEY
Department of Geology, British Museum (Natural History),
AND
Dr. C. RANDALL HOSKINS
Department of the Government Chemist

FEW, if any, fossils have given rise to more controversy than the remains discovered by Charles Dawson in gravel at Piltdown, near Fletching, Sussex, and described in 1913 by Sir Arthur Smith Woodward as representing a new genus and species of man, *Eoanthropus dawsoni*. The geological age of 'Piltdown man' was a matter of dispute from the first; moreover, this problem has latterly become linked with the question as to whether the thick but essentially human cranial bones and the remarkably ape-like lower jaw (and canine tooth) might be a chance association and represent two creatures of different geological ages. The present investigation, using the fluorine method for determination of the relative antiquity of fossil bones, has shown that the cranial bones and jaw-bone are of the same age, at the earliest Middle, more probably early Upper, Pleistocene.

Earlier Evidence

The Piltdown gravel is a thin remanié deposit in a terrace about 50 ft. above the River Ouse, containing fossil mammals of two distinct ages: a derived Villafranchian series ("Upper Pliocene" of earlier authors, now classed as Lower Pleistocene), and a later Pleistocene group, in part at least contemporary with the gravel. The "contemporary" group was classed by Dawson and Woodward[1] as "early Pleistocene", but according to more recent authorities it is not earlier than Middle Pleistocene.

To which of these two groups does *Eoanthropus* belong? This might be thought a simple question to decide by comparison of the states of preservation of the various remains. Yet examination of the specimens from this very point of view has led different authorities to diametrically opposed conclusions. In fact, anatomists regarding the mandible and canine tooth as anthropoid have felt free to place these with the Villafranchian group, and to dismiss the cranium as later Pleistocene and referable to *Homo sapiens* (cf. Marston[2]). This hypothesis is permissible in so far as mammalian remains of two ages (for example, "*Stegodon*", Villafranchian; and *Castor fiber*, post-Villafranchian) occurred with *Eoanthropus* at the base of the dark gravel (ref. 3, pp. 83–85), but it would be erroneous to claim that none of the cranial fragments was closely associated with the mandible. Although the fragments of skull-cap were for the most part recovered loose on spoil heaps, Dawson states (ref. 1, p. 121) that Smith Woodward dug out a small portion of the occipital bone "from within a yard of the point where the jaw was discovered, and at precisely the same level".

In reading their first paper, Dawson and Woodward (ref. 1, pp. 123, 143) stated their view that the human skull and mandible, being practically unrolled, were contemporary with the gravel and therefore probably "Pleistocene". However, in the discussion which followed, Sir Arthur Keith[4] argued that the skull should be assigned to the "Pliocene" group. He was influenced, he said, by the fact that in the Heidelberg jaw, of early Pleistocene date, the region of the chin was essentially human, whereas the Piltdown mandible showed simian characters. E. T. Newton[5] said that the mineralized condition of the skull bones pointed to their being of "Pliocene" age. In replying to the discussion, Dawson admitted this possibility, for he said (ref. 1, p. 151): ". . . the occurrence of certain Pliocene specimens in a considerably rolled condition, suggested a difference as to age, but not to the extent of excluding the possibility of their being coeval. The rolled specimens may have entered the stream further up the river than the human remains. . . . Then again the skull might have been surrounded by some colloid material [that is, clay] which preserved it in its passage from some earlier deposit." But in the second paper (ref. 3, p. 86) Dawson wrote: "Putting aside the human remains and those of the beaver, the remains all point to a characteristic land fauna of the Pliocene age; and though all are portions of hard teeth, they are rolled and broken. The human remains on the other hand, although of much softer material, are not rolled, and the remains of beaver are in a similar condition. It would therefore seem that the occurrence of these two individuals belongs to one of the periods of reconstruction of this gravel."

In 1935, Dr. A. T. Hopwood[6] reconsidered the evidence, and, largely on the basis of the state of preservation of the specimens, concluded that *Eoanthropus* belonged to the Villafranchian or Lower Pleistocene faunal assemblage. He pointed out that the absence of indications of rolling was unreliable as a criterion, for one of the teeth of "*Stegodon*" (*Elephas* cf. *planifrons*), undoubtedly a member of the derived group, was practically unrolled. The evidence then available, he said, justified the statement that "Piltdown Man is the oldest human fossil yet discovered" (ref. 6, p. 57).

In recent years many anthropologists have held the view that, so long as its date remained uncertain, this material was better placed in a suspense account, for the anatomical features of *Eoanthropus* (assuming the material to represent one creature) are wholly contrary to what discoveries in the Far East and in Africa have led us to expect in an early Pleistocene hominid. However, if one could at least be certain of the contemporaneity of the parts associated under the name *Eoanthropus*, and of their precise geological age, the number of possible interpretations would be much reduced.

The Fluorine-Dating Method

It has long been known that fossil bones accumulate fluorine in course of time. The major constituent of bones and teeth is hydroxyapatite, which acts as a natural trap for wandering fluorine ions. Bones absorb fluorine from the ground-water, and it becomes fixed in their substance as fluorapatite by a process of ionic interchange. Owing to the porous texture of bones (and teeth), this progressive alteration is not confined to the surface, but usually proceeds more or less uniformly throughout the body of the material. It was suggested at the British Association meeting in 1947[7] that the percentage distribution of this element in the various bones and teeth from the Piltdown gravel might reflect their relative ages sufficiently clearly to throw some light on the major problem. Later, in response to a request from the Keeper of Geology at the British Museum, the Government Chemist agreed to undertake experimental work on the fluorine analysis of fossil bones.

After preliminary trials, Mr. R. H. Settle and one of us (C. R. H.), assisted by Mr. E. C. W. Maycock, adapted published methods of analysis to the exact determination of fluorine in very small samples of bone. A description of the analytical technique and a discussion on the limits of accuracy will be presented in a report on 'fluorine-dating' to be published later in the *Bulletin of the British Museum* (*Nat. Hist.*), and it is not necessary in this article to refer other than briefly to these matters.

The method was based on that originally devised by Willard and Winter[8] and afterwards modified by various authors. The fluorine in the bone was separated as hydrofluosilicic acid by distillation with perchloric acid in presence of a few beads of soft glass to serve as a source of silica. Suitable aliquots of concentrated distillate were titrated with dilute thorium nitrate solution, using Alizarin S as indicator. The solution of thorium nitrate was standardized against solutions of known fluorine content under identical conditions, particularly with regard to titrating to the same stage in the colour change of the indicator. In the majority of cases, the amount of fluorine in the distillate was sufficient for at least three aliquots to be titrated, and the average fluorine content, after making a small correction for a blank determination, was adopted. There was generally close agreement between the fluorine contents calculated from titrations of different aliquots from a given distillation.

Where possible, at least 20 mgm. of bone was used for fluorine determination; but in several cases it was necessary to rely on samples of the order of 5 mgm. The errors of analysis naturally increase as the weight of sample decreases, but it is believed that with sample weights of 5 mgm. and upwards the error in the adopted values is not greater than ± 0·1 per cent of fluorine. For sample weights less than 5 mgm. the error may be ± 0·2 per cent of fluorine.

Approximate estimations of the iron and phosphate contents of the bones were made on residues of the samples remaining after the fluorine determinations. Colorimetric methods were used in each case (thioglycollic acid for iron, and ammonium molybdate followed by reduction of phosphomolybdate with stannous chloride for phosphate).

The fluorine-dating method was first applied to the Galley Hill skeleton[9]. Briefly, it was shown that indigenous fossil bones in the Middle Pleistocene terrace gravels at Swanscombe contain around 2 per cent fluorine, those from Upper Pleistocene deposits in the same region around 1 per cent, and post-Pleistocene bones not more than 0·3 per cent; while the Galley Hill skeleton, although found *in* the Middle Pleistocene gravels, proved to contain only about 0·3 per cent fluorine, and was therefore clearly an intrusive burial, at earliest end-Pleistocene. The Swanscombe skull bones, on the other hand, discovered in these gravels by Mr. A. T. Marston in 1935–36, showed the expected 2 per cent fluorine.

Series of bones from other sites have been analysed, and the results show that the method, although limited in scope, is useful for differentiating fossil bones of diverse antiquity when they occur mixed together, provided that the specimens compared have similar matrices. It cannot be used to determine the relative antiquity of bones from widely separated localities. The method was ideally suited to the Galley Hill problem. There seemed reasonable hope that it would help to resolve the Piltdown enigma. Accordingly, in October 1948, Mr. W. N. Edwards, Keeper of Geology in the British Museum, authorized the sampling of *Eoanthropus* and associated mammalian bones and teeth. For the most part the samples were obtained by applying a dental drill to broken or worn edges of the specimens until a small but sufficient quantity of bone powder had been cored out. Where possible, powder from several drill holes in each specimen was mixed in order to ensure a representative sample. In view of the ferruginous nature of the deposits, it was thought advisable to determine the iron content of all the samples, but we found that there is no appreciable correlation in the Piltdown material between fluorine content and iron impregnation.

In the case of coarsely porous bone, it is sometimes difficult to obtain a sample which is completely free from silt contamination. The fluorine content of a contaminated portion of a bone will obviously be misleadingly low. It was therefore decided to determine the phosphate content of all samples, and to express the fluorine value of each sample as the percentage ratio of fluorine to phosphate (as P_2O_5). This procedure facilitates comparison of the fluorine contents of bones in which there has been variable contamination.

Application to the Piltdown Material

Every available bone and tooth from the Piltdown gravel and from neighbouring deposits was analysed, including seventeen samples of the *Eoanthropus* material. The results are shown in the accompanying table. For comparative purposes the mammalian remains have been grouped according to known or probable age. Their colour, degree of rolling or other physical states have been ignored in making this age classification, except in the case of some of the sub fossil or recent specimens. The teeth of *Mastodon arvernensis*, *Elephas* cf. *planifrons* (= "*Stegodon*" auctt.) and '*Rhinoceros*' cf. *etruscus* cannot be younger than Lower Pleistocene. All the rest of the Pleistocene material from the gravel is either certainly later (*Cervus elaphus*, *Castor fiber*), or possibly later (*Hippopotamus* sp., *Equus* sp., *Cervus* sp.), than Villafranchian. Any such post-Villafranchian elements might theoretically be of first interglacial age (when according to Hopwood's terminology the "Middle Pleistocene" fauna began to appear); of great interglacial age (that is, Middle Pleistocene of all authors), or of last interglacial age (that is, early Upper Pleistocene of some authors, late Middle Pleistocene of others). Since distinctively Cromerian forms are absent and as there are indications that the deposit has been repeatedly re-worked, the post-Villafranchian material is probably partly Middle and partly Upper Pleistocene. A problem of classification typical of this site is presented by the so-called bone implement from Piltdown (*P.*18). It is part of the femur of an elephant, judged on the basis of size to be that of a member of the *Elephas meridionalis–antiquus* group. It is conceivably Cromerian (first

ANALYSES OF FOSSIL MATERIALS FROM PILTDOWN

	Fluorine %	P_2O_5 %	$\frac{\%F}{\%P_2O_5}\times 100$	Iron %
Eoanthropus I				
P.1 L. parieto-frontal (*E*.590)†	0·1 (2)*	21	0·5	7
P.2 L. temporal (*E*.591)	0·4	18	2·2	7
P.3 R. parietal (*E*.592)	0·3	17	1·8	6
P.4 Occipital (*E*.593)	0·2	28	0·7	5
P.5 R. mandibular ramus (*E*.594)	0·2 (5)	20	1·0	6
P.17 Canine (*E*.611)	<0·1	27	0·4	Trace
P.42 Molar (rm$_1$) (*E*.594)	<0·1	23	0·4	Trace
Eoanthropus II				
P.30 R. frontal (*E*.646)	0·1	13	0·8	12
P.31 Occipital (*E*.647)	0·1 (2)	17	0·6	17
P.32 Molar (lm$_1$) (*E*.648)	0·4 (2)	30	1·3	Trace
Other Mammalian Remains				
LOWER PLEISTOCENE				
P.6 Molar, *Mastodon* cf. *arvernensis* (*E*.595)	1·9	23	8·3	5
P.7 Molar, *Elephas* cf. *planifrons* (*E*. 596)	2·7 (2)	33	8·2	3
P.8 Molar, *Elephas* cf. *planifrons* (*E*.597)	2·5	34	7·4	1
P.23 Molar, *Elephas* cf. *planifrons* (*E*.620)	3·1	39	7·9	4
P.25 Molar, *Mastodon arvernensis* (*E*.622)	2·3	36	6·4	4
P.26 Premolar, '*Rhinoceros*' cf. *etruscus* (*E*.623)	2·0	24	8·3	6
POSSIBLY MIDDLE AND UPPER PLEISTOCENE				
P.9 Molar, *Hippopotamus* sp. (*E*.598)	0·1 (3)	37	0·3	3
P.10 Premolar, *Hippopotamus* sp. (*E*.599)	1·1 (3)	29	3·8	5
P.11 Antler, *Cervus elaphus* (*E*.600)	1·5 (3)	28	5·4	3
P.12 Metatarsal, *Cervus* sp. (*E*.601)	0·1	27	0·4	4
P.13 Molar, *Equus* sp. (*E*.602)	0·4 (3)	25	1·6	2
P.14 Molar, *Castor fiber* (*E*.603)	0·4	30	1·3	3
P.18 Femur, *Elephas* cf. *antiquus* (*E*.615)	1·3 (3)	30	4·3	2
P.19 Indet. bone from basal clay (*E*.616)	1·4	33	4·2	1
P.21 Incisor, *Castor fiber* (*E*.618)	0·1	27	0·4	10
P.22 Mandible, *Castor fiber* (*E*.619)	0·3	18	1·7	6
P.24 Fragment of enamel, *Elephas* sp. indet. (*E*.621)	0·8 (3)	36	2·2	1
HOLOCENE OR PLEISTOCENE				
P.36 Tibia, *Cervus* sp. (*E*.1383)	<0·1	35	0·3	1
P.37 Caprine molar (*E*.1384)	0·3 (3)	22	1·4	2
P.39 Bovine long-bone (*E*.1385)	0·1 (3)	30	0·3	9
P.40 Indet. bone (sub-fossil) (*E*.1386)	0·1	30	0·3	Trace
P.41 Indet. bone (sub-fossil) (*E*.1387)	0·3	42	0·7	2
HOLOCENE (RECENT)				
P.33 Fragment of fresh bone from soil	<0·1	33	0·3	Trace
P.34 Pelvis, *Bos taurus*	<0·1	24	0·4	4
P.35 Metatarsal, *Bos taurus* (*E*.1388)	<0·1	27	0·4	2
P.38 Ungual phalange, *Bos taurus* (*E*.1389)	0·3	32	0·9	5

* Where more than one determination of fluorine content has been made, indicated by the number in brackets, the value recorded is the average.

† The register numbers of specimens in the Department of Geology, British Museum (Nat. Hist.), are given in brackets after the description.

interglacial), more probably later, but can safely be classed as "possibly Middle or Upper Pleistocene".

In attempting to interpret the analytical results, it is important to note that there is no significant difference in the rate of absorption of fluorine by bone and by dentine. The fluorine content of the mandibular ramus of *Eoanthropus*, for example, ranged from less than 0·1 to 0·3 per cent, while that of a molar embedded in this jaw-bone was less than 0·1 per cent. If there is differential absorption, the slight advantage is with bone. There are indications that enamel is more resistant to absorption of fluorine than dentine. The analyses of teeth, with two exceptions, were based on samples which were either wholly dentine, or which included a substantial portion of dentine. The two exceptions were samples of enamel (*P*.6, *P*.24).

On the evidence of their state of preservation, the molar and premolar of *Hippopotamus* were placed by Hopwood (ref. 6, p. 49) with *Eoanthropus* in the Lower Pleistocene group. He noted, however, that *Hippopotamus* had never been recorded in a Red Crag association; so that on general grounds it would appear that these teeth more probably belong to the later group[10]. The molar, the fluorine content of which is closely comparable with that of *Eoanthropus*, shows unique preservation (*P*.9). Whereas its enamel (0·1 per cent fluorine) is practically unaltered, its dentine is stained blackish-brown throughout and contains 0·05 per cent fluorine. An X-ray powder diffraction photograph showed that this blackened dentine consists of hydroxyapatite with slight admixture, possibly, of calcium sulphate. Analysis indicated 7 per cent iron. A probable interpretation of the specimen is that at some stage of fossilization the hydroxyapatite prisms in the dentine became coated by iron sulphide which inhibited fluorine absorption. The teeth of *Eoanthropus* are in striking contrast to this *Hippopotamus* tooth, and indeed to all the associated fossil animal teeth. Drill holes in the canine and in the molars of *Eoanthropus* revealed—most unexpectedly—that below an extremely thin ferruginous surface stain their dentine was pure white, apparently no more altered than the dentine of recent teeth from the soil.

Comparison of the fluorine values of the specimens attributed to *Eoanthropus* and of the bones and teeth the geological ages of which are certain leaves little doubt that: (1) all the specimens of *Eoanthropus*, including the remains of the second skull found two miles away, are contemporaneous; (2) *Eoanthropus* is, at the earliest, Middle Pleistocene.

There can no longer be any question of *Eoanthropus* belonging to the Villafranchian group; but whether it is Middle Pleistocene or later is arguable. That the figures scarcely provide any differentiation between *Eoanthropus* and recent bones requires some explanation; but at least it serves to emphasize the probably enormous time-gap separating the former from the Lower Pleistocene material.

The wide range of fluorine content in the post-Villafranchian material (0·1–1·5 per cent) is consistent with the suggestion that this age group is composite. Although none of these specimens is markedly water-worn, the gravels could have been reconstructed at several dates without the component materials travelling far. It is interesting to recall that Dawson (ref. 3, p. 86) considered that the remains of beaver (*Castor*) were the only fossils from the Piltdown pit which could be counted as contemporary with *Eoanthropus*. This is precisely the conclusion which one would draw from the fluorine results.

The eroded (and afterwards worked) fragment of elephant femur (*P*.18, with 1·3 per cent fluorine) was not found *in situ*, but appears to have come from clay below the gravel, where it would surely have been a derivative from an older deposit. The red-deer antler (*P*.11, with 1·5 per cent fluorine) was found some distance from the skull site, and may have been preserved in a patch of gravel also representing an earlier phase of the Pleistocene. The fluorine results are, in fact, so consistent with the known or probable relative ages of the mammalian fossils in the Piltdown mélange, that it now appears justifiable to regard *Eoanthropus* and *Castor fiber* as the latest elements in the mixture, and to ascribe them to the period immediately preceding the final re-arrangement of the gravel, since which time free fluorine ions have apparently been remarkably deficient in the ground-water.

Geological Evidence : Conclusion

From the palæontological data alone, it is not possible to decide whether the final settlement of the Piltdown gravel took place during Middle or early Upper Pleistocene times.

It was pointed out by Clement Reid[11] that these gravels rest on a low plateau surface (100–120 ft. above O.D.) which was extensively developed in the Weald, but which was nowhere covered by marine deposits of the period of the submergence represented by the Goodwood raised beach (135 ft. above O.D.). In any event, it seems unlikely that this surface existed before the base levelling associated with the close of the great interglacial period. Furthermore, if the Piltdown gravel is viewed as a river terrace deposit, its position about fifty feet above the River Ouse[12] places it in a group grading with the Main Monastirian sea-level. From the temperate character of even the latest faunal elements in the Piltdown faunal mélange, it is probable that *Eoanthropus* lived under interglacial conditions, although the final resorting of the gravels may have been brought about by periglacial soil-flow (solifluxion). The question of the precise geological age of the Piltdown gravel is open to further inquiry, but taking the balance of available evidence, *Eoanthropus* may be provisionally referred to the last warm interglacial period (Riss-Würm interglacial ; that is, early Upper Pleistocene, although here it should be noted that some authorities count Riss-Würm as Middle Pleistocene).

We wish to record our thanks to the Government Chemist, Dr. G. M. Bennett, and to the Keeper of Geology, British Museum, Mr. W. N. Edwards, for their co-operation, and for permission to publish the relevant portions of this communication.

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ATOMIC ENERGY DEVELOPMENTS IN FRANCE DURING 1946–50

AT the concluding lecture of the series held at the Science Museum in connexion with the recent exhibition of French scientific instruments (see *Nature*, March 4, p. 336), Dr. L. Kowarski gave an account of "Atomic Energy Developments in France, 1946–1950". Introducing him, Sir John Cockcroft reminded the audience that Dr. Kowarski, together with Dr. H. Halban, had left France in 1940, bringing to Britain the world's largest single supply of heavy water, and that he had achieved outstanding work in the study of heavy-water moderated reactors.

Dr. Kowarski said that the French Atomic Energy Commission (Commissariat à l'Energie Atomique) was set up immediately after the Hiroshima incident and the consequent freeing of the basic information on new atomic energy studies. The provisional French Government of 1945 entrusted Joliot-Curie with the task of initiating the Commission, establishing its terms of reference, and directing it as High Commissioner. The first stages occupied some months, and the Commissariat à l'Energie Atomique came into active existence in March 1946.

The Commissariat had to form an estimate of the factors, advantageous and otherwise, which would determine its future course. In view of the international situation, work had to be undertaken independently of any other country and using only those resources available within French territory. The scientific and technical information available in France was much less than that in Britain and the United States, which meant that much pioneering experimental work would need to be undertaken. The state of France's economy during 1945–46, with industry disorganised and basic reconstruction claiming first priority, was not likely to promote quick results. The mixed character of that economy, with agriculture playing a very important part, meant a lower industrial potential, and therefore a smaller opportunity for rapid progress. Again, the French leaning towards abstract studies in the universities meant that, in comparison with conditions prevailing in Great Britain, men were not easily to be found who would have a ready understanding of the concrete problems of handling the special materials of atomic research.

In the balance were to be set some advantages. The very state of flux of French life was conducive to speedy administrative decisions. Everywhere, the spirit of reconstruction, especially among the young, was favourable to new departures. Years of instability had fostered an adventurous spirit, which could now be put to good use. The scientific tradition in the study of atomic physics was inspiring, since France might fairly claim to have cradled nuclear physics and radiochemistry. The chief favourable factor, however, was the presence in France of a handful of men with the right kind of experience.

Industrial support was essential, and France was fortunate in having in an advanced state a few of the special industries needed for basic supplies. A fairly pure kind of graphite had long been made, and a possibility of further refinement was immediately available. Non-ferrous metallurgy—an essential part of the new large-scale nuclear engineering—was well established. To support all this, France had an excellent chemical industry with the right experience in the preparation of fine chemicals.

The prime object was a nuclear reactor. To achieve this object a long chain of preliminaries was needed. First, there had to be a laboratory for exploratory experiments, then workshops for the making of special tools which in turn could be used for the making of special instruments. All this had to be built up from nothing.

A site was chosen : the abandoned fortified structure of Châtillon. Existing buildings were adapted and new buildings erected. In the face of a European shortage, sufficient machine tools were obtained and installed by May 1946. In July 1946, the first production of counters was set on foot, the right man again, by good fortune, being available with a background of electronic experience gained in radar work in Great Britain. The Collège de France supplied the basic design of counting and amplifying apparatus, and soon it was possible to send out groups of technicians to prospect for uranium in Metropolitan France and the overseas territories.

At the same time, work was begun on the construction and equipment of analytical chemistry laboratories. This was essential because of the importance of pure materials and their control. The analytical chemistry project, in fact, commanded the first priority for some months until resources were adequate. Simultaneously, however, a small factory was being set up to produce pure uranium in ton quantities, but of high purity. The factory project had to be conceived on new principles, and even though an experienced man was available to guide its planning, a year or more was needed for its completion.

The projected reactors needed men of a new kind. One may call them neutron engineers, and think of them as resembling the new electrical engineers who were called into existence eighty years ago, then as now, for the understanding and exploitation of a newly discovered force in Nature.

All the time, prospecting for uranium was going steadily on, new sources being sought and known ones assessed. A deposit of a fairly rich ore was found in France, sufficient in quantity to ensure the existence of the Commissariat à l'Energie Atomique for some years. On a quite different plane, use was made of this exploratory period to establish a legal framework for atomic energy work in France ; progress in this direction, however, was somewhat hampered by external circumstances, and several essential features remain in need of a final clarification.

In the autumn of 1947 work was begun on the construction of a nuclear reactor. As is always the case, initial ambitious ideas had to give way to more modest ones, and the design finally embarked upon was for a reactor operating at only a few kilowatts. In addition, the difficulties of making pure uranium metal meant that the reactor had to operate on uranium oxide, which could be more easily made of the requisite purity. Heavy water was used as the moderator, and at the end of 1948, after sixteen months work, and after three years of the existence of the Commissariat, the machine Z.O.E. (Z for 'zero' output, O for oxide of uranium, E for 'eau lourde') was ready to operate. It is now being shown to the general public, and such visits are considered as being outside the scope of the secrecy regulations. It develops some 5 kilowatts only, but because of its reduced bulk, the radiation intensity achieved is nearly equivalent to that of high-powered graphite piles, such as the British G.L.E.E.P.

During the past two years, work has been actively proceeding on the building of two accelerators, one a cyclotron, the other an electrostatic machine. Neither is yet ready, but it is hoped that the electrostatic machine may be ready in its essential features this year, and the cyclotron next year. The uranium factory has been equipped for the extraction of the plutonium which is produced in the pile. The plutonium is extracted for scientific interest only. Any thought of French atom bombs will be dispelled if one remembers that, to produce enough plutonium for one bomb, the only pile in France would have to operate for many hundreds of years.

A larger reactor is now under construction, in which it is hoped to achieve a higher radiation intensity than in the second British reactor. This reactor should be ready in 1951 or 1952. It is being built at a new atomic energy centre at Saclay, twelve miles from Paris, which will also house the two accelerators and other new equipment. Work on it goes forward while mining projects are pressed on at the deposits in the south-west of France.

Men are needed as much as equipment, and to produce the new nuclear physicists, teaching will have to be intensified ; for some years this may well turn out to be the most important task of the Commissariat. For the work these new men will do new materials will be needed, so new facilities for the production of pure substances will have to be brought into being.

The results already achieved are beginning to be influential outside the limits of the organisation itself. The nuclear reactor is, of course, a source of radioisotopes which can be used in many branches of research. The Commissariat à l'Energie Atomique aims at fulfilling all French requirements, but it has to be admitted that at the moment British competition must be reckoned with, owing mainly to the higher intensity of the available irradiation. Outside workers' materials can be given neutron irradiation as at Harwell. The Commissariat is also acting more and more as an information centre on matters not necessarily connected with atomic energy, but contributing to its study, and on which experience has been accumulated in the organisation. Some of these techniques have not otherwise been studied in France. Examples are high-vacuum technique and powder metallurgy. Naturally, advice is also readily available on research techniques employing radioisotopes. It is hoped that this influence will eventually be felt beyond the borders of France.

Some people express the hope that there might be a joint European effort at investigating and exploiting atomic energy. France would presumably play a leading part in any such joint effort on the Continent. So far, there is little sign of an international organisation coming into being. This is to be regretted for many reasons, among which is the loss to the common effort of the experience of countries with particular resources. For example, Switzerland or Sweden could build a powerful synchrotron, to be used by all European scientific men, with their highly developed electromechanical industry. The obstacles to joint effort are those customarily met, to which is added a specific inertia encountered whenever atomic energy is considered in the light of any one nation's national defence. Governments have been generous to atomic energy projects because of its supposed military significance, but loss of control is resisted. The physicist who looks for freedom from control may therefore also risk losing patronage.

The immediate future in France is clear. It is simply to develop the new centre at Saclay with all its requirements. What might come after, say in the development of useful industrial power, will be determined by the financial support to be obtained, and no one country in Europe can easily provide enough on its own. In the long run, a choice will have to be made in France between : (1) an effort to broaden the international basis of atomic energy work ; (2) going on in isolation, but with a greatly intensified effort ; (3) or keeping the fire of interest and experience just alive with a reasonable minimum of experimental fuel until better days come. To the question of what choice will be made, it is too early to suggest an answer.

NEWS and VIEWS

Scott Polar Research Institute, Cambridge: Bishop Fleming

THE retirement of the Rev. W. L. S. Fleming from the directorship of the Scott Polar Research Institute at Cambridge was necessitated by his transfer, at the age of forty-three, to the diocese of Portsmouth, a transfer which, seeming natural to his many friends, must be unexpected to those less closely concerned. Educated at Rugby and Trinity Hall, Cambridge, Bishop Fleming took geology, and his ability in that subject was the basis for an award of a Commonwealth Fund fellowship in the United States. Following this he took part in two summer arctic expeditions, and then Westcott House and later a fellowship and the chaplaincy of Trinity Hall claimed him. During 1934–37 he was in the Antarctic with the British Graham Land Expedition as chaplain and geologist, and was a member of the three-man sledge party which first penetrated King George VI Sound. Continued work at Trinity Hall kept him until the war-time Navy claimed him as a chaplain in H.M.S. *King Alfred*, *Ganges* and *Queen Elizabeth*. After a period as director of Service ordination candidates, he returned to Cambridge in 1946 as dean of his College and director of the Scott Polar Research Institute in succession to Prof. Frank Debenham, its founder and for twenty-five years its first director. Cambridge will greatly miss Bishop Fleming's manifold and selfless exertions.

Dr. G. C. L. Bertram

DR. G. C. L. Bertram, who succeeds Bishop Fleming at the Scott Polar Research Institute, comes to its directorship while continuing his responsibilities as fellow and tutor of St. John's College, Cambridge. Dr. Bertram was educated at Berkhamsted School and went into residence as an exhibitioner of St. John's in 1929, where zoology was his main subject. Summer arctic expeditions to Bear Island and East Greenland were followed by a period of research on coral reefs under Crossland in the Gulf of Suez, before he went to the Antarctic with the British Graham Land Expedition of 1934–37. There he accompanied Bishop Fleming and Prof. A. Stephenson down King George VI Sound, and made the southern seals his main research. After a few years back in Cambridge, he joined the Colonial Service in 1940 and went as chief fisheries officer to the Government of Palestine. Then, on transfer to the Anglo-American Middle East Supply Centre as fisheries advisor, he travelled widely over the Middle East area. Michaelmas 1945 saw his appointment to a fellowship at St. John's College, Cambridge. In 1948 he journeyed to advise on fisheries development in the Sultanate of Muscat, and in 1949 he visited the Pribilof Islands in the Bering Sea for zoological research on the great herd of fur seals.

Royal Society of Edinburgh: Prizes

THE Council of the Royal Society of Edinburgh has announced the following awards: Gunning–Victoria Jubilee Prize for the period 1944–48 to Prof. Max Born, Tait professor of natural philosophy in the University of Edinburgh, for his distinguished contributions to theoretical physics; Neill Prize for the period 1947–49 to Prof. John Walton, regius professor of botany in the University of Glasgow, for his valuable contributions to our knowledge of carboniferous palæobotany, two of which have appeared in the *Transactions* of the Society within the period of the award; Keith Prize for the period 1947–49 to Prof. A. G. Walker, Town Trust professor of mathematics in the University of Sheffield, for his papers on the general theory of relativity published in the *Proceedings* of the Society within the period, and in recognition of his distinguished contributions to Riemannian geometry.

Deutsche Medizinische Wochenschrift (1875-1950)

THIS year marks the celebration by the *Deutsche medizinische Wochenschrift* of the seventy-fifth year of its outstanding service to the medical sciences. As its own leading article says, when we turn the pages of its long succession of volumes, we feel that we are reading the medical history of the past three-quarters of a century; and we are correspondingly grateful to the men whose work created these pages. The journal was founded by Paul Börner in 1875. Robert Koch, still an unknown country medical man, was trying out a new microscope given to him as a birthday present by his young wife. This was also a time of great discoveries in chemistry and physics. While Pasteur in France was doing his immortal work, Koch, busy with his new microscope, conceived the idea of using the recently discovered aniline dyes for staining bacteria and tissues. One day, in a blood smear from a sheep, he found he had stained the anthrax bacillus, and in 1877 he finally proved, in a classical paper on this bacillus which made him famous, that this bacillus is the cause of anthrax. Most of Koch's great work was published in the *Deutsche medizinische Wochenschrift*, and the journal is rightly proud of the distinguished names in its list of contributors. They include Ehrlich, Pfeiffer, Behring, Schaudinn, Hoffmann, Domagk and leading workers in America and in Great Britain and most of the other European countries.

When Paul Börner died in 1885, the journal was edited by Dr. S. Guttmann, who on his death in 1894 was succeeded by Dr. Eulenburg and Dr. Schwalbe. Throughout its history this journal has enjoyed distinguished editorship. Since 1887 it has been issued by Georg Thieme of Stuttgart, and the printing and production of the journal, never an easy task, has maintained a consistently high standard. Medical men all over the world have for long been grateful for all the care that has gone to its production and for the great work that it has published. At this moment, when it looks back proudly over its record, all scientific men will wish it continued success in its service of humanity.

Fluid Handling

A NEW monthly journal, *Fluid Handling* (No. 1, 1949; pp. 44. London: Binjon Press; 20*s*. a year), is devoted to fluids from every point of view. It thus has a wide scope, as there are few chemical or chemical engineering operations in which fluids are not concerned. This is borne out by the variety of subjects dealt with in the first issue, which include tetracresyl silicate as a heating medium, launching a sea pipe-line, the disposal of colliery sludge and plating-shop effluents, a prototype plant for sterilization in the dairy, and proportiometer pumps. The articles are of a descriptive nature and are fully illustrated with excellent photographs and extremely clear diagrams. They serve to direct attention to new types of plant and modern installations, in a manner requiring little effort from the reader. To the man of science, the association of the maker's name with every article of equipment mentioned tends to convey the impression that he is looking through a well-written catalogue; but it must be remembered that this publication is primarily a trade journal and that makers' names are invaluable to those who may wish to purchase plant similar in nature to that described. In addition to the main articles, a number of short notes are included. These consist of personal news, information regarding new companies, company reports, book reviews, descriptions of new equipment and miscellaneous notes. The whole appearance of the journal is attractive, and those whose time is not yet fully occupied with other publications of a similar nature may well be tempted to look through its pages.

World Trade Digest

MUCH useful information about industrial developments will be found in *World Trade Digest*, which commenced publication last November and is being issued monthly (from 45 Dorset Street, London. W.1.; 1*s*.). The articles, which are well condensed and informative, are drawn from a wide range of periodicals, many of which are of a specialist nature and therefore unlikely to be readily available to the general reader. The first issue indicates that the editor will cast his net wide, for it covers such diverse subjects as the zip fastener, the channel tunnel, automatic irrigation, control of plant growth and corrosion resistance. An article on air freight, by A. James Payne, condensed from the *Recorder*, refers to the million tons of air freight carried since the War and explains that air transport saves time, reduces risks of pilferage and damage in transit, and cuts down costs on crating and packaging. British air-charter companies are now regularly carrying such things as samples, penicillin, early fruit and flowers, machinery parts for urgent repair jobs, pedigree cattle, radio sets and delicate scientific instruments. Recently, an Air-brokers Association was formed from members of the Baltic Exchange, and this should prove to be a great step forward in regularizing air-freight business.

British Standard for Photographic Lenses

BRITISH Standard 1019 (1949) is the revised form of a 1942 war-emergency standard. It is the first of a series of British Standards for lenses and is essentially in agreement with several United States equivalents. The Standard, which is divded into three sections and two appendixes, applies to camera and enlarger lenses, with the exception of box-camera lenses and single-component lenses in folding cameras. In the first section, definitions of the parts of a photographic lens, the focal lengths and associated quantities, and the lens aperture and associated quantities are given. The method of marking the focal length and the maximum aperture ratio on a photographic lens mount, together with the accuracy required for such markings, are specified in the second section. In this section, also, the standard series of stop sizes and the marking of distance scales are discussed. It is recommended in the third section that, in order to change to a stop of smaller aperture-value, the iris of the lens should be rotated in an anti-clockwise direction as viewed from the front of the lens. The methods to be used for the measurement of focal lengths and of aperture and aperture ratio are fully described in the appendixes.

This Standard has been criticized for its lack of clarity and conciseness. It does, indeed, show signs of hasty, if not careless, compilation. In several places, in order to make the text clear to the reader, textual notes have been added, but they have been inserted in the wrong places; for example, Note 2, which should follow 3*g*, follows 4*c*. Terms, such as the lens axis and nodal point, are used without definition, and in one method described the user of the Standard is expected to have previous knowledge of the position of the axial point. For methods for determining the latter point, he is referred to an out-of-the-way report by M. Hotine on air survey cameras. The Standard, in spite of its faults, fills a definite need, and it is to be hoped that an improved version will as soon as possible replace the present issue.

Distribution of Population in England and Wales

IN our note on the Registrar General's estimates of the local civilian population, which appeared in *Nature* of December 24, 1949, p. 1078, reference was made to the exclusion of conscripts away on national service from the local populations. The Registrar General for England and Wales has informed us that no information relating to the area of permanent residence of national service men is available. The number of conscripts on national service over the country as a whole could be obtained by increasing the figure for males aged 18–24 by about 44 per cent. It would, however, be unsafe to apply this ratio to local populations, as the distribution of industries varies and as there is differential reservation in different industries. In the estimate of local population for mid-1949, which is soon to be published, the number of men in the armed forces *stationed* in each area will be included. The exclusion of national service men from the local figures may be unavoidable; but we still think it unfortunate. For most purposes for which local population figures are required, it would be better to include national service men, as their absence is only of comparatively short duration. Indeed, the figure of conscripts is much more relevant to planners than an estimate of the number of men stationed in the area. The Service authorities should be able to provide the Registrar General with the material for obtaining at least an estimate of the conscripts from each area, which could be published separately from the main figures.

Use of Film in a Research Establishment

AN article by J. Rogers in the second *Bulletin of the Scientific Film Association* describes the use of films in research establishments. These include its use as a research tool, as a means of recording experimental work and of explaining and making known the results of such work; it may also be used for keeping the staff informed of the work of others. With these objects in view, a film unit was set up at the Building Research Station in 1947. So far its main use has been as a medium of explanation and information, although it has also been used for research and record purposes. High-speed cinematography has been used in research on flooring materials and has yielded interesting information on the action of an abrasion testing machine. Films are being used for record purposes in the testing of building materials to destruction, thus providing a means of re-witnessing tests which would be difficult and costly to repeat; film records are also made of certain building operations which are the subject of time and motion study. Colour film is being used in recording work carried out by the Lighting Section to render machine parts more easily distinguishable by painting them in contrasting colours; this should lead to a reduction of fatigue and an increase in efficiency of the machine operators. The Building Research Station aims at presenting information on new materials and methods to all who are in a position to influence the design and construction of buildings. Its films are, therefore, addressed to architects, surveyors, builders, technical staffs of local authorities and members of housing committees.

Drainage Evolution in the Appalachians

It has long been agreed that, following the Appalachian Revolution, the divide between east- and west-flowing streams in that region was situated somewhere east of the present Great Valley in the crystalline rocks of Old Appalacia. To-day the divide is beyond the Ridge and Valley province in the Appalachian Plateau, eight miles or more to the west of the crystalline rocks. Over a broad belt there has been a reversal in the direction of the drainage. The sequence of events that led to this change is traced by H. D. Thompson in *Annals of the New York Academy of Sciences* (52, art. 2, pp. 31–62; 1949; 1.25 dollars). He traces a long and continuous series of river captures by which the main watershed has migrated eastward and led to a general eastward slope. In extending their headquarters westward, the east-flowing streams have been influenced greatly by structure. In general, they follow weak rock formation or local weaknesses in resistant rocks; also, it is noted that long low-gradient streams are at a disadvantage in competition with those having short steep courses.

Chart for Spot Welding

The British Welding Research Association has just published a most ingenious chart for the spot-welding of mild steel. Given the thickness of the material which is to be joined, which varies from 0·01 to 0·05 inch, the chart, based somewhat on the lines of the slide rule, provides all the welding data required: weld time, weld current, tip diameter and minimum electrode-pressure can all be read off immediately. To those concerned with this type of welding it will be invaluable, and the principle on which it is constructed may well be applicable in other, and quite diverse, fields.

London Conference on Optical Instruments

Arrangements are well advanced for the London Conference on Optical Instruments which will be held at the Imperial College of Science and Technology, South Kensington, during July 19–26. The Conference is being arranged partly concurrently with the official sessions of the International Optical Commission (which will commence at the rooms of the Royal Society, Burlington House, on July 17 and will be attended by many delegates from overseas). In this way the conference will afford an opportunity of hearing speakers who are seldom able to visit Great Britain. There will be symposia on reflecting microscopes, phase-contrast microscopes, gratings and grating instruments, reflecting telescopes and spectrophotometers; and joint discussions with the international optical commission will deal with diffraction in optical instruments and new optical materials. There will be a number of miscellaneous invited papers on new instruments, such as that on the geodimeter by E. Bergstrand, etc. A number of social events are being arranged, including receptions by learned societies and excursions to optical firms and laboratories. An exhibition of optical instruments is being arranged by the Scientific Instrument Research Association. The list of speakers includes the following: Dr. F. Desvignes and Dr. M. Françon (France); Dr. R. Barer, Mr. J. Guild, Dr. H. H. Hopkins, Dr. E. H. Linfoot, Dr. H. W. Thomson and Mr. A. Warmisham (Great Britain); Dr. A. Bouwers (Holland); Prof. F. Scandone (Italy); Mr. E. Bergstrand and Dr. E. Inglestam (Sweden); Dr. W. Lotmar (Switzerland); Dr. S. S. Ballard, Mr. C. Bausch, Dr. D. S. Grey and Dr. R. Kingslake (United States). The general secretary of the Conference is Prof. L. C. Martin, Technical Optics Section, Imperial College of Science and Technology, London, S.W.7.

Conference on Civil Engineering Problems in the Colonies

A conference on "Civil Engineering Problems in the Colonies", on similar lines to that which took place in 1948, will be held at the Institution of Civil Engineers, Great George Street, Westminster, London, S.W.1, during July 3–7. The conference is designed primarily to meet the needs of members of the Colonial engineering service and others engaged in civil engineering work in the Colonies. Besides visits and excursions to places of technical interest, the programme of the conference includes: a lecture on "Public Health Engineering" by Prof. Gordon M. Fair, of Harvard University; a technical session entitled "Engineering Research and the Colonial Engineer", at which papers will be given and discussed; and two other sessions at which papers will be given on railways and docks, harbours and wharves, tropical water supplies, low-cost roads and air-port construction. The conference is open to all who are interested. The capitation fee is £5 5*s.* (£3 3*s.* to corporate members and students of the Institution), with an extra fee of £1 1*s.* if accompanied by a lady. Further details can be obtained from the Secretary of the Institution.

Announcements

The Science Museum is presenting a special exhibition showing modern ideas of weather and meteorology, and their influence on everyday life, to mark the centenary of the Royal Meteorological Society. The exhibition will be opened by the Lord President of the Council on March 27 at 3 p.m., and will be available to the public during March 28–June 25.

The Colorado School of Mines is offering a scholarship to a male student from Great Britain for the academic year 1950–51. The scholarship, which is renewable for a maximum of four years, covers tuition fees only and is worth 425–475 dollars a year. Further particulars may be obtained from the Deputy Cultural Relations Officer at the American Embassy, 5 Grosvenor Square, London, W.1, or from the Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1, with whom applications must be lodged in triplicate by May 1.

Erratum. In the list of members of the Norwegian–British–Swedish Antarctic Expedition in *Nature* of January 7, p. 8, B. Ekström is incorrectly described as Norwegian; he is Swedish.

RANGE–ENERGY RELATION FOR PROTONS AND ALPHA-PARTICLES IN PHOTOGRAPHIC EMULSIONS FOR NUCLEAR RESEARCH

By DR. J. ROTBLAT

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THE photographic emulsion is becoming more and more a tool of precision in investigations of nuclear phenomena. In order to be able to make full use of exact measurements of ranges of particles in the emulsion, it is important to know accurately the stopping power of the emulsion for particles of various energies and thus to establish the relationship between the energy of a particle and its range in the emulsion. In the old half-tone emulsions, in which the silver halide content was very low, it could be assumed that the stopping power of the emulsion relative to air was nearly constant for all energies. The present-day emulsions, however, have such a high silver halide content that this assumption is no longer valid, even approximately, and the stopping power of the emulsion has to be determined as a function of the energy of the particle. Lattes, Fowler and Cuer[1] have determined the stopping power of Ilford *B*.1 emulsions for protons and alpha-particles up to 13 MeV. Their method consisted mainly in the measurement of ranges in the emulsion of particles produced in several nuclear transmutations, the *Q* values of which were known from other experiments. Apart from possible errors, due to uncertainties in the *Q* values, a small discrepancy was present in their results due to the fact that some experiments were made with the plates exposed in air, while in others the exposures were in vacuum. Moreover, since these measurements were made in 1947, several new types of emulsions have been introduced by Ilford and Kodak, and these are now much more used than the *B*.1 type. The range–energy relation for electrons in *NT*-4 emulsions has recently been determined[2]; but there are no results available for the other emulsions. For these reasons a detailed study of the stopping power of various nuclear research emulsions for heavy particles was thought to be desirable.

The method employed consisted in exposing photographic plates to protons or alpha-particles, scattered through various angles by a beam of 8-MeV. deuterons produced in the Liverpool cyclotron. For this purpose the beam was made to pass through a chamber filled with hydrogen or helium at pressures of 15 or 10 cm. respectively. The photographic plate was placed in the chamber in such a position that the particles entered the emulsion with an angle of dip of 6–10°; in each exposure particles scattered through angles from 20° to 160° could be recorded simultaneously. The ranges of the protons and alpha-particles, as well as of the deuterons, scattered through various angles, were then measured accurately by means of a projection microscope. Since the relationship between the energy of an elastically scattered particle and the angle of scattering is well known, one can, if the energy of the primary beam of deuterons is known, calculate the energies of the particles of which the ranges have been measured.

The energy of the beam of deuterons could be calculated roughly from the condition of resonance of the cyclotron, but a more accurate value was obtained in the following way. Photographic plates were exposed, under the same conditions as in the scattering experiment, to alpha-particles from polonium and thorium-active deposit. The measured ranges in the emulsion of the alpha-particles from polonium, thorium C and C′ provided three points for the stopping-power curve of the emulsion for alpha-particles. Several angles of scattering were then chosen for the alpha-particles produced by the collisions of deuterons with helium atoms, such that their ranges were nearly the same as the ranges of the alpha-particles from polonium and thorium C. From the measured ranges the energy of the particles scattered through these angles was determined by interpolation, and in this way it was possible to calculate the initial energy of the deuteron beam. The values thus obtained agreed with each other with an accuracy of 0·1 per cent. The calculated value of the energy of the beam, 7·894 MeV., was then used for the determination of the energy of protons, deuterons and alpha-particles scattered through various angles.

This method of determination of the stopping power is independent of the precise masses of the colliding particles and is based only on the accepted values of energies and ranges in air of the alpha-particles from polonium and thorium C. The accepted range – energy relation for air and the values of the stopping power of hydrogen and helium had to be used in order to allow for the loss of energy of the deuterons before reaching the point of scattering and of the scattered particles before reaching the plate. At the pressures and distances used, this entailed in most cases a fairly small correction. At larger angles of scattering, however, the particles lost a considerable amount of energy before reaching the plate, and in these cases,

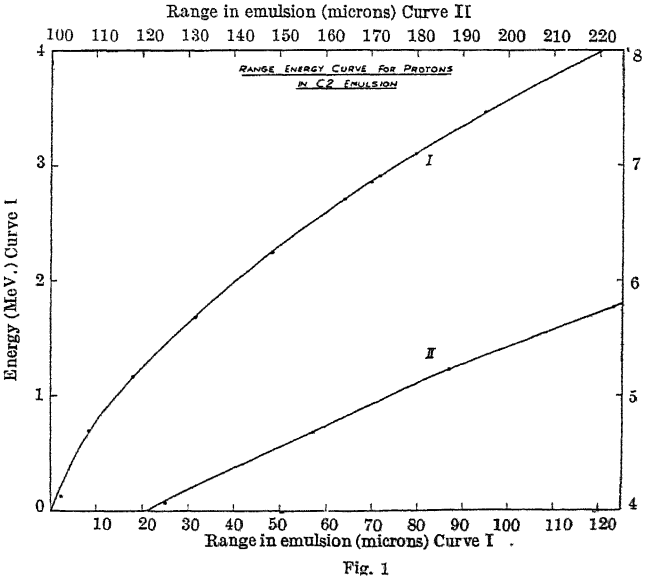

Fig. 1

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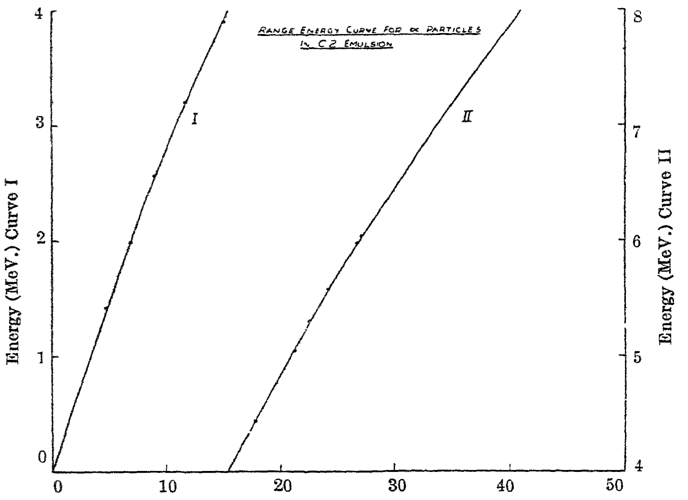

Fig. 2

therefore, the accuracy of our results is primarily determined by the accuracy of the values of the stopping power of hydrogen and helium for slow protons and alpha-particles.

We have measured the ranges of particles scattered through angles from 20° to 75°. At each angle at least 800 tracks of each range-group were measured. A Vickers's projection microscope was used with a magnification of 2,000, which enabled the range to be measured with an accuracy of ¼ micron. The range distribution obtained at each angle was fitted to a Gaussian curve, from which the mean range and the half-width could be calculated. The correction for the shrinkage of the emulsion was made from the known angle of approach of the particles into the emulsion.

Measurements were made with Ilford *C*.2 and *E*.1 and Kodak *NT*-2*a* emulsions. A few points were also taken with Ilford *G*.5 emulsion. The range-energy curves obtained for protons and alpha-particles in *C*.2 emulsion are shown in Figs. 1 and 2. At the higher ranges these results differ only little from those of Lattes, Fowler and Cuer, but significant differences occur at the lower ranges. It should be noted that our results were obtained with plates which before exposure were kept in vacuum for about two hours so that most of the water contained in the emulsion had been driven off; these have, therefore, a higher stopping power than emulsions under normal conditions. For exposures at atmospheric pressure and average humidity, the ranges have to be increased by about 3 per cent at low energies and by about 4 per cent at high energies; these correction figures, obtained in a rough experiment, are only approximate, but they are in fair agreement with values to be expected from the moisture content of the emulsion.

Straggling of range and energy in *C*.2 emulsion

Protons			Alpha-particles		
Energy (MeV.)	$\frac{\Delta R}{R}$	$\frac{\Delta E}{E}$	Energy (MeV.)	$\frac{\Delta R}{R}$	$\frac{\Delta E}{E}$
	%	%		%	%
0·69	19	13	1·42	14	12·9
1·17	10·2	7·0	1·98	8·9	8·2
1·68	6·6	4·4	2·56	6·2	5·3
2·25	3·8	2·5	3·21	4·7	3·8
2·70	2·7	1·7	4·45	3·7	2·8
3·47	2·2	1·3	5·30	3·0	2·2
4·08	1·8	1·1	6·05	2·6	1·9
5·24	1·9	1·2	8·78	2·3	1·6

The other types of emulsions investigated have been found on the whole to differ only slightly in their stopping powers. Thus, for example, for alpha-particles of several MeV., the stopping power of the *NT*-2*a* emulsion is 1–2 per cent greater than that of the Ilford *C*.2 emulsion, which, in turn, has a stopping power greater by about 0·3 per cent than that of the *E*.1 emulsion. The differences are, however, somewhat larger for low-energy protons. Exposures were also made with plates of the same type of emulsion from various batches, but no significant variations of the stopping power have been observed.

From the measured half-widths of the range distributions and the known angular divergence of the beam and its energy spread, it was possible to calculate the straggling of the range and energy for protons and alpha-particles in the emulsions. Some representative results for *C*.2 emulsion are given in the accompanying table; other types of emulsion gave the same results, within the experimental error. ΔR and ΔE are the half-widths of the range- and energy-distributions at half the maximum height. The very large straggling at low energies is naturally caused by the small number of grains in the tracks, but already for protons of an energy of 4 MeV. the straggling becomes the same as that in air. This shows that for sufficiently high energies the resolution obtainable with photographic emulsions is not worse than that of other detecting methods.

My thanks are due to Mr. E. C. Hewitt for making the measurements of the ranges, and the staff of the Liverpool cyclotron for the irradiations.

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[1] Lattes, C. M. G., Fowler, P. H., and Cuer, P., *Nature*, **159**, 301 (1947); *Proc. Phys. Soc.*, **59**, 883 (1947).

[2] Zajac, B., and Ross, M. A. S., *Nature*, **164**, 311 (1949).

THE FUNCTION OF THE BOWER OF THE SATIN BOWERBIRD IN THE LIGHT OF EXPERIMENTAL MODIFICATIONS OF THE BREEDING CYCLE

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It has been shown previously[1] that the establishment of a territory and the building of a bower as its focal point by the Australian satin bowerbird (*Ptilinorhynchus violaceus*, Vieillot) occurs in its native habitat at the period when the testes begin their seasonal expansion. At about 34° S. and 151° E. adult male birds permanently leave the winter feeding flock in June and July when the days are shortening or lengthening at a rate of a few seconds per day. Each adult male builds a double-walled bower of sticks on the forest floor across the sun's path and collects blue, straw-yellow, brown and grey flowers, parrots' feathers, snail-shells, fungi and other objects and places them in front of the bower. Meanwhile the male (which at an age of 5–7 years changes from grey-green to a glistening blue-black colour) brings a female to the bower. She usually stands impassively behind the bower while the male seizes a coloured object and displays noisily and energetically. The emphasis of this display seems often to be directed towards the object held; but the male keeps the watching female in view. The colours of the display things approximately match the blue eyes and some of the feather-colouring of the female and immature male.

If the female leaves the bower during the early weeks of the season the male stops displaying and uses a special call-note (never heard elsewhere), after which she usually returns. If she does not return the male generally leaves the bower and follows her through the forest. The mature blue-black males will not tolerate any others of their sex near the bower during the display season. If one leaves his bower unattended it is liable first to be wrecked and then to have its display things stolen by a male from a neighbouring bower. The presence of another blue-black bird—stuffed or alive—near its bower acts as a 'releaser' to instant and violent action on the part of the owner. Within three or four weeks of building its bower and bringing to it a female, the male's testes have increased in volume by more than a hundredfold and bunches of spermatozoa have appeared in the tubules. During this period there is only a comparatively minor increase in the size of female oocytes. By late in September testis-volume has increased by more than three hundredfold and free sperms have appeared in the lumina of the tubules. It is not yet known what releaser operates to transfer the male's physical attention from the coloured display things to the nearby female. But late in September or in October the female leaves the vicinity of the bower, builds an arboreal nest some hundreds of yards away and ovulates. The male continues to display at the bower.

Because the male displays alone at the bower at some periods and because it spasmodically renovates its bower and brings to it fresh display things during the post-nuptial communal flocking season, many local naturalists have claimed that 'æsthetic appreciation' and 'recreation' and not sexual motivation is the primary factor underlying bower-building and associated phenomena. An investigation of the gonad-cycle and other experimental work do not support this view.

In May 1940 two males that had previously built bowers were castrated at a period of testis regression and did not build bowers or display at the time a control bird did so. It was proposed, after a year's recovery period, to inject the experimental birds with testosterone to discover whether display and bower-building could be re-established; but the birds escaped early in 1941, and the War put an end to work for the time being. In October 1944 another bower-building mature male was castrated at the height of the display-season and of spermatogenesis. Its bower, and that of the control bird, was destroyed. The control male rebuilt immediately, but the castrate failed to do so. The following display season, however, the castrate built an imperfect bower, gathered coloured objects provided and displayed vigorously at it to females in an adjacent aviary. Transferred to a second aviary from which it could not see the females from the ground, it built another abnormal bower, but spent some time each morning displaying from a perch within view of the females. The display then waned and had almost discontinued by October 1945 at a period when control and wild birds were at the height of display. The experimental bird's interest in bower, display objects and neighbouring females seemed to have declined completely by November of the season after gonadectomy. Vocal mimicry of other species declined also.

On December 13, 2·5 mgm. of testosterone propionate was administered intramuscularly and six days later an additional 4 mgm. was given. The following day the bird was liberated in its aviary and it displayed vigorously to the females next door. A new bower was built on the former site; but it, too, was imperfect, having only one wall which ran parallel with the wall of the aviary. By mid-January the castrate had lost interest in its bower and in the females, but a further injection of testosterone caused a renewal of attention at a period when the interest of wild birds in their display grounds is declining. Two subsequent injections on January 30 and February 11, 1946, were followed by minor displays, and after cessation of treatment the bower was allowed to fall into disrepair. In April the bird was dissected and found to contain no trace of testicular tissue.

The transference of bowerbirds from southern to northern hemisphere profoundly modified the bower-building and display cycle. In March 1949, a group arrived at Regent's Park, London, and within a fortnight the most mature male (at the time of writing it is mottled green and blue in plumage-change) had built a bower and begun to display at a period when British birds are becoming sexually active and when bowerbirds in Australia possess regressed gonads and have deserted their territories. It would seem probable that the environmental factors that stimulate breeding activities in northern hemisphere species may correspondingly influence the sexual cycle (and through it bower-building and display) of Australian bowerbirds.

Experimental removal of individuals of either sex from the bower further emphasizes the sexual and territory implications of bower-building. In the forest a preliminary bond has been established between a given pair before the bower is built. Once established, territory and bower assist the male to keep other males out; and his display keeps the female within his ambit until she has been fertilized. Females were removed as they watched individual males display in late July and in mid-August. In each case the male succeeded in bringing another female to his bower within a week. After losing a second female at his bower, one male removed his display things to another site two hundred yards away and attracted a third female to the new bower. On two occasions blue-black males were experimentally removed from their bowers. In each case the female remained in the territory and she and the bower and decorations were taken over by an immature and apparently unattached grey-green male. The bower, then, is a means to a speedy re-mating and ultimate synchronization of the sexual processes of a new pair if either of the originals is killed. One grey-green male, collected for examination a week after taking over a female and bower, had seminiferous tubules packed with thick bunches of spermatozoa. Young cryptic-coloured males are therefore sexually mature. Some of them build full-sized bowers and probably breed, but their display things are often stolen by the more aggressive blue-black males of the neighbourhood. This was proved by checking the movement of diamond-scratched fragments of blue glass from bower to bower.

Territorial aggression and the capacity to collect and to retain by active intra-specific competition appropriate display things confers a high probability that a given blue-black male will breed. Despite the domination of mature blue-black males over the grey-green younger ones during the sexual season, no evidence is yet available that polygamy occurs. Nests of *Pt. violaceus* are hard to find, and in dense forest it is extremely difficult to connect a nest with a bower, for the conspicuous male apparently takes no part in nest-building, incubation or the rearing of the young. There is histological evidence that the male is potentially polygamous. After shedding spermatozoa the testes of monogamous species collapse and the seminiferous tubules undergo a massive fatty metamorphosis[2]. Two blue-black males, collected while displaying at bowers in December (two months after fertilization date), still possessed testes of about maximum size. These were packed with bunched spermatozoa. Spermatogenesis was still actively proceeding and only the first signs of fatty metamorphosis showed. The remarkable continuation of male interest in the display ground is therefore accompanied by an apparently undiminished capacity for reproduction. It is only when the female and young appear in the bower-territory in January that the male display discontinues and the testes collapse. The blue-black owner of the bower and a party of green-grey birds (up to half a dozen in number) disport themselves about the playground and then leave the territory to join communal, nomadic feeding flocks which noisily range through the fruit-trees. The normal number of eggs per clutch is one to three.

It is not known what are the external stimuli that influence the breeding cycle and cause the males to take up territory as early as mid-winter, though it is probably advantageous for an individual to gain territory early. There appears to be no change in the frugivorous diet at the time the flocks break up. In captivity, *Pt. violaceus* eats insect food all the year if it is made available. However, experiments show that it does not scratch aside leaves or other debris under which insects or land crustaceans take refuge. Again, it makes no attempt to open a transparent cocoon through which a motionless organism is clearly visible. It will, however, pursue flying insects[3]. Hirst[4] has evidence that suggests that captive satin bowerbirds are unable to bring young to maturity on a largely non-protein diet even though they bred several years in succession. Whatever are the factors that delay ovulation until late September or October, it is clear that the delay ensures that the young will be launched at the time of year when the forest is full of flying insects. 'Sudden flushes' of bogong moths (*Agrotis infusa*) occur during September and October, and swarms of winged termites (*Coptotermes lacteus* and *C. acinaciformis*) suddenly appear from September to February. Towards the end of October cidadas emerge in millions, and the following month enormous numbers of 'Christmas'-beetles (*Anoplognathus* spp.) appear*. Although the territory habit spreads the bowerbird population over the available forest, there seems no obvious connexion between bower-territory and food supply. Both sexes gather food in common ground outside the sphere of bower-influence.

The odd visits of males to their territories during the post-nuptial flocking season when the gonads are small offers no support for the hypothesis that bowers are primarily 'recreational' in function. Howard[5] has shown that it is general for many British species to visit their territories in winter, and Morley[6] has listed about seventy birds that show autumn or winter sexual behaviour. Again, there is now evidence[2] (and Marshall and Coombs, unpublished) that the avian testis, in autumn and winter, is not necessarily inactive but has become regenerated in the lipoid and cholesterol content of its interstitial cells. This regeneration enables the production of a season's second brood in some species and may be correlated with the post-nuptial display that is so widespread among birds.

At the same time, it is not at present suggested that bowerbirds do not get pleasure from their vocal mimicry of other species, from their extraordinary gyrations at the display grounds and from the colours of the objects that they bring to them. No opinion at present can be offered as to the function, æsthetic or otherwise, of a final remarkable habit: that of painting or plastering the inner walls of the bowers with a mixture of charcoal and saliva or with fruit-pulp. Some writers have claimed that *Pt. violaceus* shows in this connexion intelligence and "deductive reasoning". The habit is common only at the time of spermatogenesis.

Experimental work is being continued in Great Britain.

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* Phenological data have been kindly supplied by Mr. Anthony Musgrave, Curator of Entomology, Australian Museum, Sydney, and operative assistance has been had from Mr. J. Newcombe and Dr. A. Bollinger.

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[4] Hirst, A., *Vict. Nat.*, **58**, 7 (1940).
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[6] Morley, A., *The Ibis*, **85**, 132 (1943).

METALLURGICAL APPLICATIONS OF THE ELECTRON MICROSCOPE

A VALUABLE and stimulating symposium on metallurgical applications of the electron microscope was held in the Lecture Theatre of the Royal Institution on November 16, 1949. The meeting was organised by the Institute of Metals in association with seven other learned societies. The president of the Institute of Metals, Sir Arthur Smout, was the chairman for the morning session, and in the afternoon the chair was taken by Dr. F. C. Toy, president of the Institute of Physics. The sessions were well attended by a representative international gathering of electron microscopists and by metallurgists interested in this new technique for the study of metals. Following the usual practice of the Institute of Metals, copies of all the contributed papers were available before the meeting, and summaries of the papers to be discussed at each session were presented by *rapporteurs*—by Dr. V. E. Cosslett at the morning session, and by Dr. N. P. Allen at the afternoon session. A large part of each session was therefore available for discussion.

In the papers presented during the morning session, the emphasis was mainly on technique. The opening paper, by Dr. N. P. Allen of the National Physical Laboratory, considered very briefly the historical background and the development of the electron microscope to the stage where it has become a useful metallurgical instrument. It was written from the point of view of the metallurgist, and concluded with a formidable list of metallurgical problems awaiting solution where the electron microscope might prove to be a valuable tool. Electron microscopy in France was represented by Prof. P. Grivet, of the Sorbonne, who surveyed the development of the instrument and of the techniques employed with particular reference to the C.G.T.S.F. electrostatic instrument, in the development of which he has played a large part. After a brief account of the application of the microscope to the study of small particles and to metallurgy, the author described some recent developments of emission and scanning microscopes in France.

The paper by Dr. H. Mahl, unfortunately very brief, was little more than a catalogue of the work carried out in Germany during and since the War. An interesting micrograph of a fractured steel surface obtained by the aluminium pressing method was shown, and in view of Dr. J. Nutting and Dr. Cosslett's contribution on the same topic, one would have liked to have heard more of this work. These authors have made certain modifications of the method, and have produced results which are comparable with those of Mahl. The results are of a preliminary character and show promise of providing valuable information on the process of fracture. In a second paper, Drs. Cosslett and Nutting, of the Cavendish Laboratory, Cambridge, described an investigation of the influence of etching conditions on the stripping of 'Formvar' films of different thicknesses from pearlite and sorbite in a range of carbon steels. The sixth paper in the morning session, by Dr. G. L. J. Bailey and Miss S. Vernon-Smith, of the British Non-Ferrous Metals Research Association, was concerned principally with the study of non-ferrous alloys, preceded by a survey of replica methods and some of the artefacts which may arise in plastic replicas. They have studied grain-boundary structure in β-brasses containing aluminium, grain-boundary precipitation in aluminium-magnesium alloys, and several other aluminium alloys. γ-Phase was shown to be precipitated in the grain boundaries of the high-tensile brasses which are subject to brittle fracture. Dr. C. M. Schwartz contributed an interesting and valuable survey of the methods employed in the United States for the examination of metal surfaces by electron microscopy and of some of the results that have been obtained.

In introducing these papers, Dr. Cosslett considered briefly the rapid development of the electron microscope in the past fifteen years and compared it with the development of the X-ray diffraction technique. He thought that any new instrument or technique goes through three stages—development, use in research laboratories, acceptance as a technological tool. For example, the X-ray method is now widely used in research and as a tool for the control of technological processes. The electron microscope seems to have reached the second stage in its history, and, provided that certain prejudices can be overcome and that every care is taken to establish confidence in the instrument, there is no reason why it should not pass on to the third stage. The discussion was opened by Prof. G. I. Finch, of the Imperial College of Science and Technology, with an appeal to electron microscope users to avoid scientific myopia, to treat the electron microscope as an aid to research to be used in conjunction with other methods and to leave the design of instruments to the makers and to electron opticians. He thought that much of the controversy over the interpretation of results could be overcome by suitably planned and often simple experiments; in particular, he was critical of the attention given to hypothetical explanations of artefacts arising in plastic replicas. By way of answering some of Prof. Finch's criticism, Dr. Bailey elaborated the discussion of artefacts in his paper and gave an expression relating film thickness to the viscosity of the plastic solution and the time after withdrawing the specimen from the solution. Mr. J. Trotter, of the National Physical Laboratory, directed attention to some of his recently published results which establish that artefacts can arise in the way postulated by Bailey and Cosslett, but also show that these effects may not always be introduced by the replica.

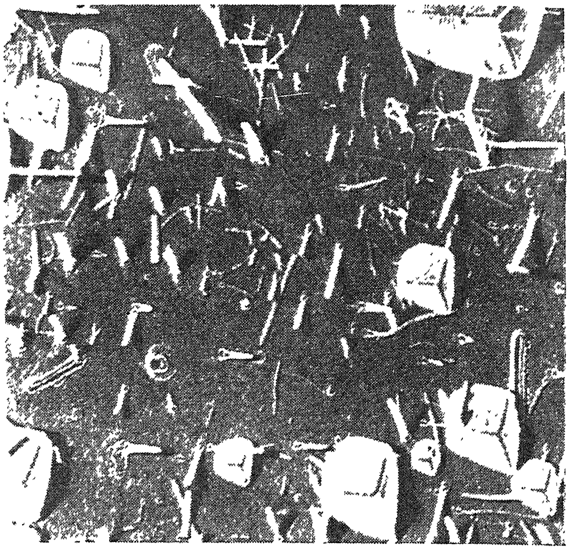
There was a lively discussion of the micrographs of pearlite illustrated in Dr. Nutting's paper and of an aluminium pressing replica of the same material, in which Dr. W. Hume-Rothery, Dr. Allen, Dr. Cosslett and Dr. A. F. Brown joined. Dr. Allen mentioned some work carried out at the National Physical Laboratory by Messrs. F. W. Cuckow and J. Trotter in which the transformation of a steel at about 400° C. has been studied by phase-contrast microscopy, and by the plastic and silica replica processes in the electron microscope. The results are such as to give confidence in the plastic replica process. Prof. Grivet referred to the advantages of dark-field illumination in certain cases, particularly where it is desired to distinguish between amorphous and crystalline material. As an example, he projected a micrograph of a thin section of rubber prepared by normal illumination and another prepared with dark-field illumination. In the latter, the crystalline particles of zinc oxide could be clearly seen. The limitation of resolution imposed by the molecular size of such materials as polystyrene and 'Formvar' was raised by Prof. Finch, who said that it had perhaps been inferred that there was no such limitation with aluminium oxide replicas, and he questioned the accuracy of this inference. Could it be assumed that the aluminium oxide is formed in the molecular state ? Mr. Agar mentioned the pre-shadowing technique which has proved valuable in the biological field, and he said that he has had some limited success in applying it to metallurgical studies.

The papers discussed in the afternoon session were concerned mainly with metallurgical investigations rather than with the technique of electron microscopy. The paper by Messrs. Trotter, D. McLean and C. J. B. Clews, of the National Physical Laboratory, described an examination of the microstructures of a series of iron–carbon alloys. The electron micrographs reveal detail beyond that visible with the light microscope. An important feature of the work is the wide variety of microstructures which can exist in a specimen of given carbon content. Dr. F. Keller, of the Aluminium Co. of America, reviewed the various methods of specimen preparation used in the study of light alloys, and some of the results obtained. It appears that the 'critical size' of precipitate particles to obtain optimum strength or hardness in age-hardening light alloys varies appreciably with the type of alloy and the hardening constituent. In an aluminium–magnesium–silicon alloy the particles are $0 \cdot 02 \mu$ in size, while for a fully aged aluminium–silver alloy they are as large as 0·5 μ. Messrs. G. L. Bucknell and G. A. Geach, of the Associated Electrical Industries Research Laboratory, have also studied age-hardening, in this case in an aluminium – 1 per cent copper alloy using the oxide replica process. They show an interesting series of micrographs, including two which purport to show plate-like precipitation after ageing at room temperature.

The slip processes in aluminium were the subject of a contribution by Dr. A. F. Brown, of the Cavendish Laboratory, Cambridge. He has extended the electron microscopic investigations of Heidenreich and Shockley to the study of deformation at temperatures from −180° to 500° C. He found that at all temperatures the slip zones seen in the light microscope could be resolved into elementary slip lamellæ, and that the width of these lamellæ and the amount of slip do not alter with temperature, the only difference being in the grouping of the lamellæ. The lamellæ were 200–800 A. thick and the slip distances were 1600–2200 A., the higher values in both cases being found at higher temperatures. Nickel–chromium alloys used in heater elements were examined by Messrs. B. S. Cooper and G. A. Bassett, of the General Electric Co. They found that the methods of specimen preparation used in optical microscopy were unsuitable, and it was therefore necessary to study the effects of several etching reagents. An interesting series of comparative electron micrographs were shown. The last paper, by Mr. J. I. Morley, of Brown-Firth Research Laboratories, was rather different in character and was concerned with the examination of metal powders in the electron microscope. The micrographs show tungsten powders produced by different methods and the effect of ball-milling on particle-size. Attention was also directed to the use of shadowing to give information about the height of particles and the profile of their upper surfaces.

In introducing these papers, Dr. Allen considered them mainly from the point of view of a metallurgist, and he also took the opportunity of referring to matters of metallurgical interest in the papers discussed at the morning session. He mentioned the σ-phase work of Mahla and Nielson, and Heidenreich's study of the carbide precipitates formed during the tempering of martensite quoted in Schwartz's paper. Etch patterns exhibited by Grivet, by Geach and Bucknell, and by Cooper and Bassett show the need for more information on the nature of the etching process if full value is to be obtained from electron micrographs. Although the interpretation has given rise to controversy, the use of the aluminium pressing method holds promise for the examination of fractured surfaces. The widely different structures which can be found in a given metallurgical specimen emphasize the need for care in basing any conclusions on a single electron micrograph.

Mr. G. L. Bailey, director of the British Non-Ferrous Metals Research Association, opened the discussion. He thought that while the papers in the symposium had gone far to give the metallurgist confidence in the instrument, it was not yet completely established in the field of metallurgical research. He questioned certain features in a number of the micrographs, and this had the useful effect of stimulating the ensuing discussion. M. R. Castaing, of the Office National d'Études et de Recherches Aéronautiques, Paris, described some very interesting work on the ageing of 4 per cent copper-aluminium alloy and on an aluminium alloy containing magnesium and silicon. The precipitation was shown at an early stage of the ageing process, and it has been established by X-rays and by the examination in the electron microscope of shadowed oxide replicas containing etch pits that magnesium silicide (Mg_2Si) is precipitated in such a way that the (111) planes of the magnesium silicide lattice are parallel to the (100) planes of the matrix. Some very striking electron micrographs were shown (see accompanying illustration). Prof. A. Guinier made a few general remarks in which he emphasized the need for correlating optical and electron microscopy and X-ray diffraction when studying age-hardening phenomena. He said that the electron microscope cannot observe the very thin plates of precipitate known as Guinier–Preston zones although the latter can be detected by X-ray methods. Since no zones or larger precipitate can be found by X-rays after room-temperature ageing, he thought that ageing must have been produced in the specimens examined by Geach and Bucknell by some unknown factor such as heating in the electrolytic polishing bath. These authors agreed that the specimens may have been warmed in this way.



Aluminium alloy containing 0·8 per cent magnesium, 0·5 per cent silicon aged for 24 hr. at 250° C. Oxide replica, chromium-shadowed. × 12,000. (R. Castaing)

Some work on 4 per cent copper–aluminium alloy was described by M. A. Saulnier, of Chambéry, who has made dilatometric observations, hardness measurements and electron micrographs on the same specimens. Micrographs show the precipitation between 175° and 350°, and an attempt has been made to relate the three sets of observations. Dr. Brown enlarged on the remarks of the *rapporteur* and referred in addition to some experiments on the use of methyl methacrylate as a replica material. This is polymerized on the surface of the metal, and it has been possible to show the presence of slip lines. Mr. Challice mentioned the 'orange peel' etch pattern shown on aluminium oxide replicas, and stated that he had observed a similar effect with an oxide replica of an electropolished iron specimen. Dr. Allen and Mr. Bailey were doubtful of the value of certain micrographs which show unusual etch figures (for example, the work of Cooper and Bassett), and a number of speakers referred to similar results found by other workers. The work of Chalmers and

King on the thermal etching of silver shows that the etch patterns differ widely, depending on the crystallographic orientation of the material. Recent developments in France of scanning and emission microscopes were briefly described by Prof. Grivet. In the scanning microscope, which he is developing in collaboration with Prof. Guinier, a fine electron beam falls on the specimen, and the X-rays generated are detected in a Geiger–Muller counter. Dr. P. Coheur, of C.N.R.S., Liège, in referring to the paper by Trotter, McLean and Clews, mentioned some of his own investigations on steel specimens. He has extracted the carbides from the steels by the alcoholic iodine method, for X-ray examination. Following on this topic, Dr. Clews gave a brief account of some recent work on the tempering of martensite, comprising an electron microscope study, the examination of the etched metal surface by electron diffraction reflexion patterns, and subsequent X-ray examination of alcoholic iodine residues. The results are in excellent agreement among themselves and with some unpublished work by Jack.

Since its inception in 1932 a very great amount of development, both of the instrument and its associated techniques, has been necessary; but from the papers presented and the discussion which followed, there is no doubt that the electron microscope has now become an important tool for the study of metal surfaces. An interesting exhibition of electron micrographs was arranged in the ante-room to the lecture theatre, and methods of replica preparation were demonstrated at the end of the meeting.

C. J. B. Clews

BRITISH NON-FERROUS METALS RESEARCH ASSOCIATION

NEW LABORATORIES

Sir Ben Lockspeiser, secretary of the Department of Scientific and Industrial Research, opened extensions to the laboratories of the British Non-Ferrous Metals Research Association on February 13. This was made the occasion of a Press conference at which some fifty representatives of the daily and technical Press were present. After an introductory talk by Sir Ben, the visitors toured the laboratories and saw work in progress. On the next three days the laboratories were open to some seven hundred guests, mostly from the technical staffs of member companies, but with many from Government departments, universities and research associations.

The new extensions were provided by reconstruction of a building destroyed during the War; they represent for the present the concluding stage of a programme of enlargement which has been in progress for some years. The Association now has well-balanced facilities to undertake the work which the non-ferrous industry requires.

The basement of the new building contains the new metal-working laboratory, with equipment intended for the production of any special wrought metals required for use in the Association's experimental work. Such specimens have hitherto been provided by the willing and generous assistance of member companies at some inconvenience to themselves. The equipment of the metal-working laboratory includes a 500-ton down-stroke hydraulic press which can be used for extrusion or press forging; a 12 in. × 12 in. rolling mill equipped with plain rolls for sheet and strip production, and grooved rolls for the production of bar material; two smaller presses (one for powder metallurgy), a drawbench, machine tools and other ancillary plant.

The first floor is devoted to the general metallurgy section, for which laboratory facilities have hitherto been inadequate. Equipment is available for the study of slag/metal and gas/metal reactions, and includes sensitive apparatus for the extraction of gases from metals and their subsequent analysis. A 7-kW. output high-frequency induction furnace is available for gas-extraction work where resistance heating is inconvenient, for oxygen determinations by vacuum fusion of metals in carbon and as a general tool in the study of equilibria at high temperatures. Studies are in progress of the copper/phosphorus/oxygen equilibrium and of properties of copper-smelting slags affecting smelting losses, a subject of interest to Commonwealth copper producers. These laboratories also contain various heat-treatment furnaces and a 20-kW. carbon resistor vacuum-furnace of the Kroll type, used, for example, in the melting of titanium: the Association is taking a very active part in research sponsored by the Ministry of Supply into the possibilities of titanium and its alloys. The general metallurgy section also includes the equipment for routine metallographic examination used in all the Association's researches. Special metallographic work has included the development of the use of diamond dust for metallographic polishing, for example, for thin coatings on hard-basis metals, and the design and construction of equipment for micro-hardness testing.

It should, however, be emphasized that these new extensions of the British Non-Ferrous Metals Research Association laboratories, important though they are, form only a part of the total space, apparatus and plant available, all of which were inspected by the visitors on the open days. In the present brief notes it is impossible to describe the entire establishment and the researches in progress: attention will therefore be limited to some facilities available for the application of physical and physico-chemical techniques and apparatus to the study of fundamental metallurgical problems.

In corrosion research, application is made of measurements of corrosion currents and electrode potentials, if necessary with continuous recording. Electrode potentials must be measured with instruments which take a negligible current, otherwise the electrode under observation might be polarized, yielding an untrue result. Measurements are therefore usually made with valve voltmeters or other instruments incorporating some degree of D.C. amplification. A number of instruments are in use (some adapted for continuous and multiple recording) which take maximum currents from 10^{-8} to 10^{-14} amp. In respect of the study of corrosion, mention may also be made of the polarograph; primarily an instrument for analytical purposes, this has been used for demonstrating differences in the character of supply waters which are not apparent from other methods of investigation. The various electrochemical methods mentioned have been applied, for example, in the course of investigations on the corrosion of galvanized steel and of copper. Another electrochemical technique, the measurement of voltage-current curves over very short time-intervals, is being applied to the study of the anodic film which is believed to be of importance in the mechanism of electropolishing.

The Association's physics laboratories are equipped with an electron microscope, an electron-diffraction apparatus and an X-ray generator, with a wide range of cameras. The techniques thus available are applied as required throughout the Association's work both in its internal research programme and as *ad hoc* service to assist member firms in dealing with current technical problems. The electron microscope is proving of special value in the study of grain-boundary structures, which have been found to be of great importance in the technical properties of alloys. Electron-diffraction has been applied usefully to the study of the adhesion of electrodeposits on aluminium alloys and to the examination of the oxide films formed on liquid and solid metals, while the X-ray equipment is in constant use for the identification of chemical compounds and for studies of the constitution and texture of materials. In the physics section also, measurements of surface energy and surface tension are throwing light on soldering, brazing and hot-dip metal coatings ; while multiplier photocells are being applied to the direct measurement of the intensities of spectral lines, in further development of the Association's well-known investigations on the spectrographic analysis of metals.

CHEMICAL ATTRACTANTS FOR INSECTS: SEX- AND FOOD-ODOURS OF THE COTTON LEAF WORM AND THE CUT WORM

By PROF. B. FLASCHENTRÄGER
AND
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WE have been investigating the cotton leaf worm (*Prodenia litura*, Fab.) and the cut worm (*Agrotis ypsilon*, Rott.), the most harmful pests of cotton in Egypt[1-3]. Female moths are found to attract the male moth and not vice versa, as with the gypsy moths[4]. If the females are separated in a glass chamber from the males, no attraction occurs. The odour of the female appears an hour after hatching and is restricted to the last two abdominal segments. The sex-odour disappears from the cut abdominal segments in a vacuum, but reappears again after 15 min. under normal pressure. It disappears totally after one and a half hours. It can be extracted from the abdominal segments with purified ether, and the ethereal residue shows the same power of attraction as the living moth. This proves that the female attracts the male by one or more chemical substances and not by sound or radiation.

We have developed an apparatus (an odour-analyser) which enables us to study sex- and food-odours chemically and biologically simultaneously. It consists of three parts : an odour-developer containing the females or the food, the odour-receiver with which we investigate the physical and chemical properties of the odours, and the odour-tester in which the males are able to migrate against the odour-stream and not the reverse. With this apparatus the sex-odour of the cotton leaf worm was found to be a volatile, neutral substance or mixture ; it could be frozen out at -20° C. It was stable against dilute sulphuric acid and dilute sodium hydroxide. With concentrated sodium hydrogen sulphite we were able to extract the sex-odour from the air-stream. This suggested the presence of an oxo-group in the molecule.

We found that fermenting 'bouza', the Egyptian wheat-beer[5] which is used in the Andree–Maire trap to attract the moths of cotton pests[1,2], contains a volatile mixture, consisting mainly of ethanol and acetic acid. However, pure ethanol attracts very few moths, and acetic acid does not attract any moth ; but a mixture of the two attracts many more. The bouza odour is volatile with steam and can be frozen out. It is stable with dilute sulphuric acid and 1 per cent formalin, but is partially destroyed by dilute sodium hydroxide. Concentrated sodium hydrogen sulphite had no effect on bouza-odour, in contrast to its effect on the female sex-odour.

The extraordinary sensitivity of the sense organs of insects enables us to investigate with our apparatus some of the chemical properties of sex- and food-odours, in order to find the best way of enriching them and also to test the fractions of extracts.

Reports on this work were given on September 29, 1948, at Frankfurt before the Deutsche Physiologische-Chemische Gesellschaft (*Angew. Chem.*, **61**, 252 ; 1949), and on November 30, 1948, at the Faculty of Science, Farouk I University, Alexandria.

[1] Bishara, I., *Bull. Soc. Roy. Entomol.*, **18**, 288 (1943) ; *Tech. and Sci. Service Bull.*, **114**, 1 (1932) (Ministry of Agriculture, Cairo: Government Press).

[2] Willcocks, F., "The Insects and Related Pests in Egypt", **1**, Pt. 2 (Cairo, 1937).

[3] Kamal, M., *Proc. VI. Internat. Congress Entomol., Madrid, 1935*, **2**, 567 (1940).

[4] Haller, H. L., Potts, S. F., and Acree, F., *J. Amer. Chem. Soc.*, **66**, 1659 (1944).

[5] Monib, M., Fac. of Agriculture (Cairo, 1948).

[6] See also Dithier, A. M., "Chemical Attractants and Repellents" (London, 1947). Wigglesworth, V. B., "The Principles of Insect Physiology" (3rd. edit., London, 1947). Moncrieff, R. M., "Chemical Senses" (London, 1944). Frisch, v. K., "Duftgelenkte Bienen im Dienste der Landwirtschaft und Imkerei" (Wien, 1947).

PERCEPTION AND MEASUREMENT OF ODOUR

A LECTURE in Esperanto on "The Perception and Measurement of Odour" was given by Dr. D. R. Duncan on January 17 at University College, London, at the conclusion of the annual general meeting of the British Esperanto Scientific Association. Dr. Duncan first reviewed the attempts which have been made by Linnæus[1], Zwaardemaker[2], Henning[3], Crocker[4] and others to evolve systematic classifications of the known types of odour, mainly on the basis of subjective judgments of similarity and dissimilarity. He felt that Zwaardemaker's was by far the best attempt ; but that the real solution of the problem demands attack by other methods, including a quantitative approach. Dr. Duncan described the *p*O scale of odour intensity and various instruments which have been used for estimating odour intensities, including the Fair–Wells osmoscope[5] (which is now an article of commerce) and an improved apparatus designed by Dr. G. H. Cheesman and himself. He gave reasons for assuming that there is a limited, though large, number of primary odours, other odours being produced by simultaneous stimulation of more than one type of receptor.

He then described unpublished work carried out by himself in a preliminary attempt to analyse odours. Of various methods employed, he has found the method of odour 'fatigue' most helpful. Prolonged exposure to one odour reduces the sensitivity of the nose to other similar odours and often leads to striking changes in the apparent odours of other substances. In cases where no change in intensity or character of odour occurs, it may be assumed that there is no primary odour in common, and the converse should also be true. By quantitative measurements of loss of sensitivity under standard conditions of fatigue, it may even be possible to effect a quantitative analysis of odour stimuli, a line which is being pursued by Dr. Cheesman.

Dr. Duncan has concentrated on the study of the qualitative changes, supported by rough estimates of sensitivity changes due to fatigue and by more accurate odour-mixing experiments. Dr. C. M. Bean has independently carried out qualitative work on odour fatigue on much the same lines. In broad terms, the results confirm that Zwaardemaker's classification has a considerable element of truth in it.

The main difficulty in such work is to make an intelligible written record of the subjective observations; but by concentrating on a small group of odours (Zwaardemaker's classes 1 and 2), it has been possible to reach some definite results. In illustration, evidence was presented which suggests that the odour of *cyclo*hexanol differs from that of *cyclo*hexanone in that the former contains about 1 per cent of a component not present in that of *cyclo*hexanone but present as a major component in the odour of tertiary butyl alcohol, while the odour of *cyclo*hexanone contains instead about 6 per cent of a component also present as the major component in the odours of acetone, methyl ethyl ketone and tetrahydrofuran. The primary stimuli common to *cyclo*hexanol and *cyclo*hexanone, producing an overall minty effect, include: (1) an 'aromatic' component present in the odours of menthol, camphor, eucalyptus oil, weakly in the odour of *iso*butyl alcohol and very weakly in those of *cyclo*hexane and *cyclo*hexylamine; (2) a sweet sensation (probably stronger in *cyclo*hexanone than in *cyclo*hexanol), present also in menthol and more powerfully in *cyclo*hexane and many chlorinated hydrocarbons, particularly chloroform—this sensation is stated by Henning to be due to stimulation of taste buds present in the nose; (3) possibly, but very weakly in comparison with menthol, a component stimulating the temperature-sensitive nerves in the nose.

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[2] Zwaardemaker, H., "Die Physiologie des Geruchs" (Leipzig, 1895).

[3] Henning, H., "Der Geruch" (Leipzig, 1916).

[4] Crocker, E. C., and Henderson, L. F., *Amer. Perfumer*, **22**, 325 (1927).

[5] E. and A. Bull. No. 524 from Messrs Eimer and Amend, New York. Fair, G. M., and Wells, W. F., *J. Amer. Water Works Assoc.*, **26**, 1674 (1934).

STUDY OF METEOR VELOCITIES

ON October 26, Dr. J. G. Porter, president of the British Astronomical Association, delivered his presidential address, taking as his subject "The Study of Meteor Velocities"*. As a result of the Harvard–Cornell Meteor Expedition in Arizona during 1931–33, it was believed that most meteors were moving with highly hyperbolic velocities—a conclusion which Dr. Porter never accepted. He spent some years in investigating the subject with the utmost care, and showed that the methods adopted in the Harvard–Cornell Expedition were unsound, and he found no real evidence that any meteors were hyperbolic. It is significant that none of the meteors doubly photographed by members of the Expedition showed hyperbolic velocities, and it is now generally accepted that meteors are members of the solar system. Dr. Porter's analysis of about three thousand meteor observations*, from which there were sufficient doubly observed to give the real paths of 778, showed in addition that, contrary to the opinion of a number of experienced workers in meteoric astronomy, there was no essential difference between the heights of appearance and disappearance of the shower and sporadic meteors.

Dealing with the relation between a number of well-known meteor showers and the comets usually associated with them, Dr. Porter pointed out in his address that the usually accepted view that these meteors are the debris of the comets is open to considerable doubt. In support of the contrary view, he referred to the Leonids and Perseids which have been active for a thousand years and to the Lyrids which have been active for about two thousand years, but the comets with which they are associated were not discovered until the nineteenth century. A more convincing case is found in Comet Giacobini–Zimmer: in 1926 the meteors associated with this comet came from particles in front of it, not from the debris following behind. Dr. Porter considers it more simple to assume that this and other comets are moving along in orbits with the dust that is responsible for the meteoric showers, such dust being quite independent of the comet, though it is just possible that in the remote past both may have been derived from a common source—perhaps from a great comet which disintegrated. Further corroboration for this view is found in the work of the Computing Section of the British Astronomical Association (of which the president is director), which was carried out during the Second World War. Of all known comets, it was shown that only sixty approached the orbit of the earth within 0·1 astronomical unit, while thirty-five came within 0·05 unit. There did not appear to be any connexion between these (with the exception of six) and any meteor showers—a result which is very significant if meteor showers are formed from the debris of comets.

Many other points were discussed by Dr. Porter: but it is impossible to deal with all of these in this article. One important development in meteoric work referred to in the address, however, may be mentioned, namely, the application of radar to determine radiants and also speeds of meteors. Very useful work has been accomplished already, and we may confidently look forward to great strides in the near future. The discovery by radar of the great daylight streams in 1946 was a new departure in meteoric astronomy, and one can scarcely predict what further important developments will take place in the next few years. It is interesting to notice that in the past very few radiants seemed to be active in September, and this has been confirmed by radar.

In the course of the address, Dr. Porter appealed for more observers of meteors and also for more computers who would use the observational results to determine real paths. He mentioned a mechanical apparatus under construction which will facilitate such computations and will, in fact, give the heights and path-lengths of meteors directly.

* *J. Brit. Astro. Assoc.*, **60**, 1 (1949).

* The results appeared under the title, "An Analysis of British Meteor Data" (*Mon. Not. Roy. Astro. Soc.*, **103**, 3; 1943, and **104**, 257; 1945). See also *Nature*, **152**, 420 (1943); **155**, 761 (1945).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Measurements of the Energy of Beta- and Gamma-rays with a Scintillation Counter

Broser and Kallmann[1] have shown that mono-energetic alpha-particles give pulses of the same height in a scintillation counter, and that the pulse-height is proportional to the energy of the alpha-particles. It is found in studying the pulses for some beta-radiating substances that there is proportionality between pulse-height and energy also in this case. The same result is obtained when studying the pulse-height from the gamma-rays emitted by different substances. There is, in this case, a continuous distribution of pulses from zero to a certain maximum height which corresponds to the continuous distribution of Compton electrons produced in the absorption of the gamma-rays. By determination of the end-points of the distributions, a rough measure is given of the energy of the gamma-rays. Recently Jordan and Bell[2] have published some measurements of that kind. This method gives rather uncertain results, especially for gamma-spectra with more than one energy. I have therefore tried to determine the pulse-height corresponding to those photo-electrons which are created at the absorption of the gamma-rays in the phosphor.

If one uses in the scintillation counter a phosphor which contains elements of high atomic weight, a fairly large number of photo-electrons will be created; and those electrons should give a maximum in the distribution of pulse-height, which would be easier to determine than the end-point of the Compton distribution. A number of gamma-radiating substances have been investigated and the maxima corresponding to the photo-electrons have been found in every case. A sodium (thallium) iodide phosphor was used; the pulses from the photo-multiplier (R.C.A. 1P21) were amplified by a linear amplifier and the pulse-height was studied by means of a discriminator. An example is given in Fig. 1, which shows the curve obtained for sodium-24. The number of counts in a small pulse-height interval is plotted against the pulse-height. The maxima corresponding to the two energies 1·4 and 2·8 MeV. can be seen.

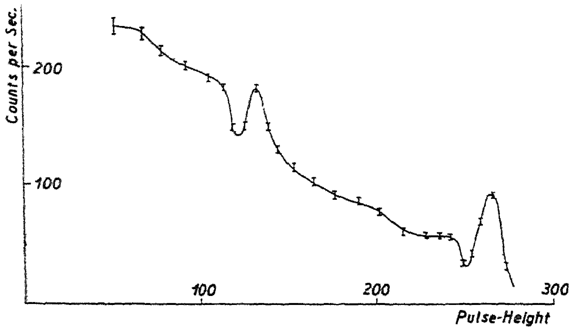

Fig. 1

To use this apparatus for the measurement of gamma-energies, it must be calibrated with known[3] gamma-spectra. Fig. 2 shows this calibration curve. The pulse-height corresponding to the photo-electrons from different gamma-rays has been plotted against the energy of the rays. The diagram shows that the pulse-height is proportional to the energy, and also gives an indication of the accuracy that can be attained with this method. The uncertainty seems to be of the order of 2–3 per cent.

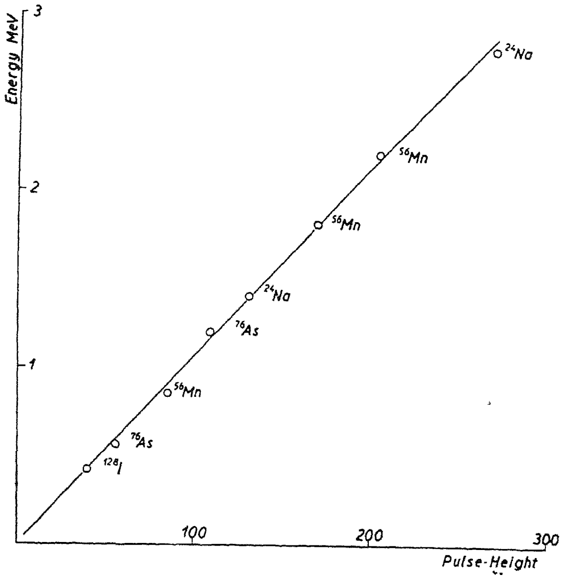

Fig. 2

The calibration curve of Fig. 2 applies to the photo-electrons of the gamma-rays. It should be possible, however, to use it for the measurement of electrons in general, for example, from a beta-emitting substance. As a check on the calibration curve, the pulse-height distribution was measured for a number of beta-emitters: manganese-56, iodine-128 and radium E. By means of the Fermi plots from these measurements and the calibration curve, the maximum energy of the beta-rays was found. The following values were obtained (the corresponding values according to Mattauch[3] are given in brackets for comparison): manganese-56, 2·82 ± 0·05 MeV. (2·84); iodine-128, 2·04 ± 0·04 MeV. (2·02); radium E, 1·19 ± 0·03 MeV. (1·17). It is thus possible to measure beta-spectra with a comparatively good accuracy by means of scintillation counters. The method will be more useful, however, for the measurement of gamma-rays, because of the possibility it affords of measuring very weak samples.

A more detailed account of this work will be published elsewhere.

Sven A. E. Johansson

Department of Physics,
University of Lund.
Nov. 11.

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[1] Broser, I., and Kallmann, H., *Nature*, **163**, 20 (1949).

[2] Jordan, W. H., and Bell, P. R., *Nucleonics* (Oct. 1949).

[3] Mattauch–Flammersfeld, "Isotopenbericht" (1949).

Adaptation of a *Coli* Phage to an Acridine Derivative

Fitzgerald and Lee[1] have shown that certain acridine derivatives, in concentrations tolerated by the bacteria, prevent the multiplication of the corresponding coliphage *T* 2. They were able to neutralize this inhibiting action by the addition of nucleic acid.

With a different coliphage and the corresponding *Esch. coli*, we have obtained similar results. The inhibitor used was 3,6-diamino-10-methylacridinium chlorhydrate. Incidentally, we may mention that heparin and another sulphuric ester, that of cellulose, suppress this inhibiting action.

Using the Hershey technique for counting the phage particles, we have obtained the following results. If instead of ordinary agar we use nutrient agar plates containing 0·0002 per cent of the inhibitor, the majority of the phage particles fail to give rise to plaques, a plaque count from a typical experiment giving 15,000 particles per c.c., a parallel count on ordinary agar giving 2,400 million particles per c.c. If, however, one of the plaques from the 'acridine' agar is transferred to broth containing 0·0002 per cent inhibitor, and subcultures are made, a count after ten passages gives the following results: on ordinary agar, 3,400 million particles; on 'acridine' agar, 2,760 million particles per c.c. This adapted phage, after three passages in 'acridine' broth, was subcultured eight times in ordinary broth, a subsequent count giving, on ordinary agar, 1,900 million particles and on 'acridine' agar 1,090 million particles per c.c.

Coliphage can be adapted to produce plaques on 'acridine' agar, and adaptation persists after eight passages in ordinary broth, each passage entailing an initial phage dilution of 10^{-4}. The adapted phage also shows a certain adaptation towards acridine orange, the only other derivative tried to date. Whether this adaptation is due to selection or mutation is still an open question. Full details of these experiments will be published elsewhere.

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Nov. 9.

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[1] *J. Immunol.*, 52, 127 (1946)

Electron-Microscope Study of the Peritrophic Membrane in *Dixippus morosus*

DURING the course of an examination of natural membranes, which might be studied directly with the electron-microscope, it was observed that the peritrophic membrane of the intestine of *Dixippus morosus* presented several interesting features. It has a submicroscopic structure more or less comparable with that of the nuclear membrane in oocytes of *Triturus torosus* and *Xenopus lævis*[1].

The mid-gut was emptied and the peritrophic membrane isolated, washed in distilled water, placed wet on the object-carrier, and allowed to dry in the atmosphere. The electron-microscope examination was carried out using a tension of 60 kV. The peritrophic membrane shows a more or less regular network structure, probably fibrous, with a thin film stretched across the holes of the network (Fig. 1). This thin film shows no visible structure. Rapid drying, or the action of an intense electron beam, brings about a tearing of the film or a reduction in thickness, leaving, apparently, true holes in the network. On gold-shadowed preparations a relief structure appears, the thicker fibrous network standing out above the thin films (Fig. 2).

The relative number of 'holes' and of 'thin films' in the meshes of the network varies from one preparation to another (compare Figs. 2 and 3).

Further work is required before discussing the interpretation of this structure, its origin and its physiological function; in particular, membranes from other species of insects must be studied.

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CHARLES HAASSER

École Nationale Supérieure de Chimie,
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Strasbourg.

Nov. 15.

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[1] Callan, H. G., Randall, J. T., and Tomlin, S. G., *Nature*, 163, 280 (1949).

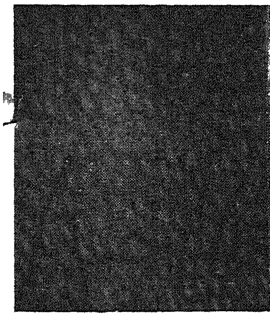

Fig. 1

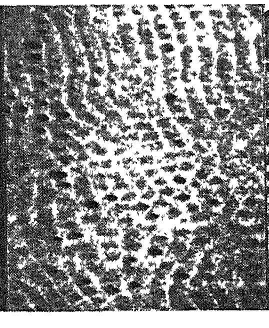

Fig. 2

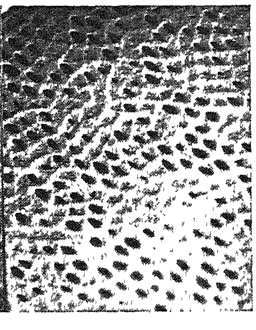

Fig. 3

Quinone-tanning in the Mollusca

THE presence of proteins tanned by an orthoquinone has been established in certain arthropodan cuticles[1–3] and in trematode egg capsules[4]. Recently, Dennell[5] has shown that the chætæ of the earthworm *Allolobophora* are hardened by quinone-tanning. He also suggested that quinone-tanning of protein structures may be a widespread occurrence in the invertebrates. Observations which have been recently made on the bivalve ligament indicate the presence of a similar phenomenon.

The ligament of *Anodonta*, like that of many other bivalves, consists of two main layers, the outer and the inner[6]. The former is amber in colour and appears to consist largely of tanned proteins; the inner layer is calcified, is white in colour and only occasionally shows signs of slight tanning. The Millon and xanthoproteic tests give positive results only in the outer layer. Evidence that the amber coloration of the outer layer of the ligament is due to tanning by an orthoquinone is given by the fact that, even after boiling, it induces a rapid oxidation of the Nadi reagent (a mixture of dimethyl*para*phenylenediamine and α-naphthol), which has been used to indicate orthoquinones in insect and crustacean cuticles[2,3]. The argentaffine reaction for polyphenols and polyamines is most marked in the outermost region of the outer layer.

A detailed account of this work will be published elsewhere.

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Effect on the Embryo of Staleness of the Sperm at the Time of Fertilization in the Domestic Hen

IT is a well-known fact that the domestic hen is capable of yielding fertile eggs for a considerable period after mating and isolation. Interest has centred around the incidence of fertility after different periods of isolation and the viability of the embryos obtained. A high incidence of mortality during the early stages of development has been recorded; but little or no attention has been given to the cause of this mortality.

Experiments have been in hand during the past three years, in the University of Liverpool, to discover, if possible, what the effect on the embryo might be of the 'staling' of the sperm within the genital tract of the female. A detailed study, involving flock and stud matings of hens, incubating all the eggs laid over a period of four weeks after isolation, and serially sectioning more than 200 embryos of the 48- and 72-hr. stages, has shown that: (1) the eggs laid during the period of isolation tend to give abnormal embryos; (2) in the later days of isolation, just before the cessation of fertility, *only* abnormal embryos are produced; (3) the abnormalities are of a consistent type characteristically affecting the nervous system and the vascular system, accompanied by a general retardation of development; (4) the head end of the embryo is mainly involved, and next in frequency the tail end, the middle length being relatively normal; and (5) the nature and site of the abnormalities approximate remarkably closely to those obtained artificially by other workers by the injection of toxic substances into the fertile egg prior to incubation.

Aberrations of the nervous system manifested themselves as irregular swellings of the wall of the brain and spinal cord, erratic foldings of the brain and overgrowth of the neural folds and their faulty union, resulting in the formation of a plug of neural tissue projecting into the neural cavity. Quite frequently the neural folds failed altogether to unite to form a tube. Abnormal vascular systems were exemplified by hypertrophy of the embryonic blood vessels and heart, over-vascularization of the vascular membrane and hæmorrhage into the extra-embryonic body cavity. In general, only the ectodermal and mesodermal derivatives were affected, the endoderm being quite free from irregularities.

The results obtained have been so consistent as to afford strong grounds for the view that a sperm, by its sojourn in the genital tract of the female before fertilization, becomes toxic to the zygote and tends to cause abnormal development of the resulting embryo. This work is being continued, and a detailed paper is being prepared on the results already obtained.

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Aureomycin in the Treatment of Yaws and Tropical Ulcer in Africa

AMONG the diseases which fill the out-patient departments of hospitals and dispensaries in tropical Africa, yaws and tropical ulcer are undoubtedly the most time-consuming. Up to the present, yaws has been treated solely by injections of bismuth, arsenicals or penicillin. The two former compounds are by no means free from toxic effects, and though penicillin is of low toxicity its use necessitates daily intramuscular injections which are not popular with the small children who form the bulk of patients treated for yaws. If a drug were effective in yaws when given by oral administration it would obviously be of very great value.

Aureomycin has been found to be effective in clearing up the lesions of secondary syphilis[1–4]. It also acts on the spirochætes of relapsing fever[5]. The following observations show that aureomycin given by mouth is effective in clearing up the secondary lesions in yaws. Three children all with florid secondary yaws were given aureomycin, six capsules (250 mgm. per capsule) daily for seven days. As African parents consider that yaws treatment without injections cannot possibly be effective, the three children were also given a daily injection of 2 ml. of physiological saline as a placebo. No change in the lesions was noted until the fifth day of treatment, and treponemata could still be seen in the lesions up to this time. On the fifth day the lesions began to dry up and by the seventh day they had almost completely healed. The children gave positive Kahn reactions at the time of beginning treatment and continued to show positive Kahns for six weeks after ceasing treatment, although they remained in good health and exhibited no relapse. Thus, as in syphilis, so in yaws, aureomycin brings about rapid healing of the lesions, but in the doses so far used no serological changes have been noted. As compared with results from penicillin treatment of yaws in the same area in Africa[6,7] aureomycin is somewhat slower in action than penicillin; but it has the advantage of not requiring intramuscular injections. It would thus be simpler to carry out mass treatments with aureomycin than with penicillin.

Four patients with tropical ulcers were also treated with aureomycin by mouth. The ulcers before treatment showed a heavy discharge of foul-smelling pus which was teeming with spirochætes and fusiform bacilli. No local treatment was applied except lint soaked in distilled water. Aureomycin was given by mouth in doses of either four or six capsules daily and was continued for 4–7 days. Within twenty-four hours the number of organisms in the pus had decreased, and within forty-eight hours the surrounding œdema had subsided and smears from the ulcers now showed an almost complete absence of spirochætes and fusiforms. The ulcers in all four patients went on to complete healing, and the results were surprising. Aureomycin seems to be as rapid in its action when given by mouth as penicillin when given by intramuscular injection. Further observations are being undertaken to determine the most satisfactory dosage of aureomycin in both yaws and tropical ulcer.

Our thanks are due to Lederle Laboratories Division, Cyanamid Products, Ltd., for the generous supply of aureomycin, and to Prof. G. A. H. Buttle, in whose laboratory the pathological investigations were carried out. One of us (G. M. F.) is in receipt of an expenses grant from the Medical Research Council.

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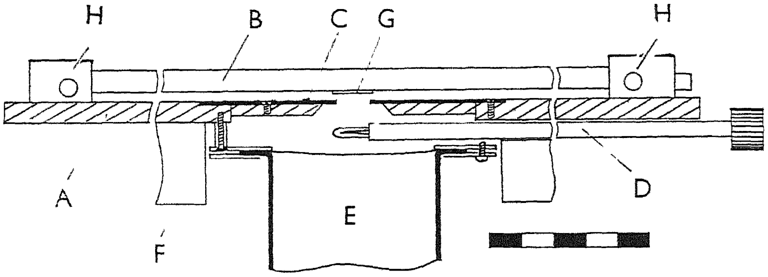
A Radioactivity 'Scanning' Device for Paper Chromatograms using Phosphorus-32

An apparatus has been developed for measuring quantitatively, by counting, the distribution of radioactivity on filter paper chromatograms. The specific purpose in view has been to measure the amounts of radioactive phosphorus present in various phosphate esters as separated on filter paper chromatograms by the methods described recently by Hanes and Isherwood[1].



Sectional drawing of scanner: scale in centimetres. *A*, ¼-in. brass plate; *B*, glass plate; *C*, thin brass plate with 1 sq. cm. hole; *D*, ophthalmoscope lamp mounting; *E*, part of 2-in. Geiger–Muller counter; *F*, part of lead shielding ('castle'); *G*, celluloid pressure plate; *H*, angle-pieces and ball-catches retaining glass plate

Details of a number of scanning devices have been published[2,3,4]. In the apparatus to be described, the size of the area scanned is 1 sq. cm. The apparatus consists of a flat ¼-in. (6·4-mm.) brass plate, into which is let a thinner plate of 1 mm. brass in which an accurate 1-cm. square hole has been cut. The size of the apparatus and the position of the hole are such that any portion of a 23-cm. wide paper of any length may be scanned. The positioning of the paper is determined (1) by illuminating the paper from below the square hole, and by carefully aligning over the illuminated hole one of a number of centimetre squares in a grid very accurately drawn in pencil on the spot to be scanned, and (2) by applying pressure on a covering potassium-free glass plate (39·4 × 20·0 cm.) normally supported off the brass plate by four ball-catches mounted at the corners. The pressure on the glass is applied, when counting is in progress, by means of a 2·5-cm. thick lead disk, 10 cm. in diameter, which also serves to screen from external radiation a Geiger–Müller counter, mounted window upwards behind the square hole.

A number of details of construction help to improve the accuracy of scanning. The square hole was accurately made to within 0·001 cm. by trimming the edge of a 9·9-cm. square hole with a specially made gouge. This had the effect of leaving slightly raised lips along the edges of the hole on one side of the brass. These lips, when mounted uppermost, aided the necessary close contact between the edge of the brass and the paper. This contact was further improved by the use of a 1·2-cm. square piece of thin celluloid cemented to the glass plate above the hole to act as a pressure plate.

An experimental model Geiger–Muller counter with a 2-in. (5·08-cm.) end-window of 'Dural', made by the General Electric Company, Ltd., Wembley, has been used in this apparatus, as it was found that a 1-in. (2·54-cm.) diameter end-window counter was not sufficiently accurate for the purpose of scanning so large an area as 1 cm. square. The sensitivity of a 1-in. diameter counter to points along a plane at right-angles to the axis decreases considerably 3–4 mm. from the axis (cf. Putman and Boxall[5]), a much shorter distance than the half-diagonal of the 1-cm. square.

During alignment, the paper was illuminated by a small ophthalmoscope lamp mounted at the end of a ¼-in. (6·4-mm.) tube of plastic material which could be moved longitudinally so that, when counting was in progress, the lamp was withdrawn from the path of the β-particles to the counter window. By using this type of lamp, only ⅛ in. (3·2 mm.) in diameter, it was possible to reduce the distance of the paper from the window of the counter.

The glass plate, the edges of which were vertical and polished, was retained in place by angle-pieces and ball-catches, partly shown in the drawing, which limited its easy movement. Since this ensures a constant position of the glass in relation to the square hole, it is probable that a system of marks in the glass might be used as an alternative means of aligning the paper.

Tests with this apparatus have shown that spots with known quantities of radioactive phosphate, but of different areas, can be scanned to an accuracy of about 1 per cent.

I am indebted to Mr. H. Overhill, of this Laboratory, for constructing this apparatus.

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Application of Paper Partition Chromatography to the Separation of the Polyhydric Alcohols

Baker[1] has described the isolation of dulcitol, a non-reducing sugar alcohol, from the exudate of the leaves of *Euonymus japonica*. An investigation of this exudate by partition chromatography on strips of filter paper, employing the usual solvents for sugar analysis, revealed that dulcitol gives rise to a discrete dark brown spot on the paper chromatogram when it is sprayed with an ammoniacal solution of silver nitrate and heated. Other polyhydric alcohols, such as mannitol, sorbitol, glycerol and ethylene glycol, also reduce ammoniacal silver nitrate under these conditions, a most surprising and unpredictable result. In view of the importance of partition chromatography for the analysis of intimate mixtures of the reducing sugars[2], an examination of the properties of the polyhydric alcohols on the paper chromatogram was necessary in order to avoid any confusion between these closely related substances. It is of interest to note that Partridge[3] has encountered inositol, a cyclic hexitol, along with glucose and fructose in an extract of the fœtal blood of sheep, since he found that it also gives rise to a discrete brown spot on the paper chromatogram with the ammoniacal silver nitrate reagent.

The R_f values of a number of the polyhydric alcohols on Whatman No. 1 filter paper have been determined in various solvents, using the normal procedure[3] for sugar analysis. Small circular spots of aqueous solutions of the alcohols (approximately 2·5 per cent w/v) were put on the paper strip for chromatography; much larger amounts of glycerol and ethylene glycol may be used, however, small spots of the syrup giving excellent results. A solution of silver nitrate (5 per cent) to which ammonia (s.g. 0·88) had been added in excess was used for their detection on the paper chromatogram.

R_f VALUES OF VARIOUS POLYHYDRIC ALCOHOLS AND SUGAR GLYCOSIDES

Solvent (v/v)	*n*-Butanol saturated with water	*n*-Butanol 4·0, ethanol 1·1, water 1·9	*n*-Butanol* 4, ethanol 1, water 5	Benzene 1*, *n*-butanol 5, pyridine 3, water 3	*n*-Butanol 5, acetic acid 1, water 2
Trimethylene glycol	0·67	0·62	0·63	0·63	—
Ethylene glycol	0·51	0·54	0·61	0·58	0·58
Glycerol	0·30	0·43	0·37	0·46	0·44
α-Methyl galactoside	0·13	0·31	0·18	0·35	0·31
α-Methyl mannoside	—	—	0·31	—	—
β-Methyl maltoside	—	—	0·03	—	—
Sorbitol	0·06	0·21	0·10	0·21	0·17
Dulcitol	0·05	0·21	0·10	0·20	0·18
Mannitol	0·05	0·22	0·10	0·22	0·19
Inositol	0·00	0·10	0·02	0·07	0·05
Sucrose	0·00	0·15	0·03	0·18	0·09

* These mixtures formed two phases; the upper phases were used for chromatography.

Ethylene glycol moves rapidly on the paper chromatogram and is readily separated from glycerol, which, in turn, is easily distinguished from the hexitols, which travel relatively slowly. Ammoniacal silver nitrate is a very sensitive reagent for the hexitols and glycerol, since it will detect as little as 1 μgm. of the polyhydric alcohol. In the case of ethylene glycol, however, it will detect only 10 μgm. Trimethylene glycol also reduces ammoniacal silver nitrate under these conditions; but the reaction is rather weak and it is necessary to use a small spot of syrup for chromatography.

The sugar glycosides, such as α-methyl galactoside, α-methyl mannoside and β-methyl maltoside, and sucrose, a non-reducing disaccharide, also reduce ammoniacal silver nitrate under these conditions and, using this reagent, it is possible to detect approximately 10 μgm. of any one of these materials.

The polyhydric alcohols do not give any colour reactions with aniline trichloroacetate and hence they are readily distinguished from the reducing sugars and the methyl glycosides, which show specific colour reactions[4].

The chromatographic separation of the sugar alcohols on columns of native clays such as 'Florex XXX' have been described by Wolfrom and his co-workers[5,6]. Since the sugars may be separated one from another by partition chromatography on columns of cellulose[7], however, it follows that by the application of similar principles a method is available for the separation of relatively large quantities of the polyhydric alcohols. The polyhydric alcohols may be determined quantitatively by periodate oxidation[8], and hence intimate mixtures of these substances may be estimated, in a similar manner to the sugars[9], by the use of partition chromatography. The mixture is separated on a sheet of filter paper by partition chromatography, the components extracted from the paper chromatogram, oxidized by sodium metaperiodate and the resultant formic acid estimated using the procedure of Hirst and Jones[9], thus affording a method for the quantitative micro-estimation of the mixture.

I wish to thank Prof. Wilson Baker and Dr. J. K. N. Jones for their interest and advice.

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Isomerization of Dianisylcarbinyl Nitrite to Dianisylnitromethane

Claims to have isomerized nitrous esters to the corresponding nitro-compounds by heating the vapour at 100–130° [1,2] have not been substantiated by later workers[3]. It seems probable that this may be due to decomposition of the nitrous ester giving nitric oxide and the alkoxyl free-radical, which then undergoes disproportionation, yielding the corresponding aldehyde and alcohol. By analogy with the sulphinate–sulphone isomerization[4], it was considered probable that the nitrite–nitro isomerization would require the formation of the carbonium and nitrite ions, and it seemed likely that this isomeric change would be facilitated by employing an alkyl group which readily forms a carbonium ion, and also by choosing experimental conditions which would tend to suppress free-radical formation and favour ionization.

It has been found that dianisylcarbinyl nitrite, prepared from dianisylcarbinol and nitrosyl chloride in the presence of pyridine, decomposes at room temperature yielding mainly dianisyl ketone; however, on reduction of the decomposition products with either tin and hydrochloric acid, or iron and acetic acid, a small amount (0·8 per cent) of dianisylmethylamine can be isolated as the N-benzoyl derivative, melting point 173–74° (found: C, 76·0; H, 6·26; N, 3·90 per cent; $C_{22}H_{21}O_3N$ requires C, 76·1; H, 6·05; N, 4·03 per cent), undepressed in melting point on admixture with a specimen obtained by the benzoylation of dianisylmethylamine, melting point 56–57° (found: C, 73·6; H, 7·15; N, 5·52 per cent; $C_{15}H_{17}O_2N$ requires C, 74·1; H, 7·00; N, 5·76 per cent), prepared by the reduction of dianisyl ketoxime. The freshly prepared dianisylcarbinyl nitrite and the decomposition products obtained by heating the ester in chloroform solution at 100° yielded no amine on reduction; but when the ester was kept in glacial acetic acid solution containing a trace of hydrochloric acid at 0° C. for 12 hr. and the products reduced, 7·2 per cent of amine was isolated as the crystalline benzoyl derivative.

Since no amine was isolated on reduction of the freshly prepared nitrite, it is concluded that in those experiments where dianisylmethylamine was isolated isomerization to dianisylnitromethane had occurred.

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An Oxidation Involving the Hydroxyl Cation, $(OH)^+$

A SHORT time ago we reported[1] that hypobromous acid became a powerful brominating agent in the presence of mineral acids owing to the production of bromine cations:

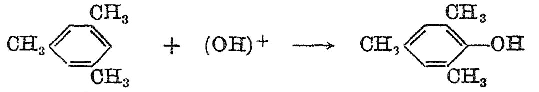
$$H^+ + HOBr \rightleftharpoons H_2O + Br^+ \text{ (or } (H_2OBr)^+).$$

It therefore seemed possible that hydrogen peroxide might react similarly with mineral acids to give hydroxyl cations, $(OH)^+$, or $(H_3O_2)^+$, and, indeed, Evans and Uri[2] have computed that the equilibrium constant for the reaction

$$H^+ + HO—OH \rightleftharpoons (H_2\overset{+}{O}—OH) \; (\rightarrow H_2O + OH^+)$$

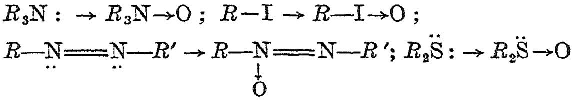
should have a value of the order of 10^3; thus in 10 N acid solution hydrogen peroxide should be about 1 per cent converted into the active cation, $(OH)^+$.

Evidence of cationoid substitution by the $(OH)^+$ cation confirms that these hypotheses are correct, and there can now be no doubt that hydrogen peroxide can oxidize aromatic compounds in the presence of strong mineral acids, though not in aqueous or acetic acid solutions. When hydrogen peroxide is added to an aqueous solution of benzene, there is no apparent reaction; but when concentrated sulphuric acid is poured as a layer below this mixture, then the boundary is at once marked by a brownish-black ring of oxidized material. Since phenols are much more easily substituted than benzene, hydroxylation by $(OH)^+$ tends to produce highly oxidized products. However, by taking mesitylene (I) and hydrogen peroxide in acetic acid – sulphuric acid mixtures, we have been able to show: (*a*) that the consumption of hydrogen peroxide is an acid-catalysed process, and (*b*) that mesitol (II) is a major reaction product. The fact that mesitol is already substituted in all *ortho* and *para* positions to the hydroxyl group prevents its destruction by further rapid hydroxylation.



I II

Hitherto it has been suggested tentatively[3,4] that the epoxidation of olefins by perbenzoic and peracetic acids may involve a positively polarized hydroxyl group, that is, $AcO—\overset{\delta-}{O}——\overset{\delta+}{OH}$; but no simple reaction diagnostic of the hydroxyl cation has hitherto been described. The conception of hydroxylation by the $(OH)^+$ cation in acid media immediately affords a simple explanation of many oxidations which involve the addition of oxygen to a lone pair of electrons to give products containing dative bonds; for example:



$$R_3N: \rightarrow R_3N\rightarrow O; \; R—I \rightarrow R—I\rightarrow O;$$
$$R—\underset{..}{N}=\!=\underset{..}{N}—R' \rightarrow R—\underset{\overset{\downarrow}{O}}{N}=\!=N—R'; \; R_2\ddot{S}: \rightarrow R_2\ddot{S}\rightarrow O$$

and has significant implications in connexion with many other oxidation processes. Among the reactions of hydrogen peroxide itself, we now may recognize oxidations due to (*a*) the $(OH)^+$ cation, (*b*) the $(\cdot OH)$ neutral radical and (*c*) the $(O—OH)^-$ anion. Each of these has well-defined characteristics, and it is not difficult to discriminate between them.

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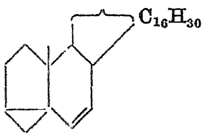
Bicholestatriene

IN an attempt to find a new route to 7-dehydrocholesterol (provitamin D_3), a coloured steroid was encountered which is believed to be a bicholestatriene. A brief description of this compound is given here pending further details.

The starting material is Δ^6-*i*-cholestadiene (I) prepared from *i*-cholesteryl methyl ether[1]. (I) was brominated with N-bromosuccinimide (Ziegler reagent)[2] in carbon tetrachloride, using a trace of benzoyl peroxide as a catalyst[3]. The bromine atom entering at C_8 is easily removed as hydrogen bromide giving $\Delta^{6,8(9)}$-*i*-cholestatriene (II), and the liberated acid tends to cause the rearrangement of the *i*-steroid to the normal structure. Many reagents (potassium acetate, diethyl aniline, calcium carbonate or barium carbonate) were used with varying degrees of success to neutralize the mineral acid liberated during the reaction.

The bromination mixture, a light brown resin, was not readily resolvable into pure individual components by crystallization, so the mixture was dissolved in acetone and treated with 65 per cent sulphuric acid[1] to affect the opening of the *cyclo*propane ring and the rearrangement of the *i*- to the normal structure. A buttery material separated out from which a yellow solid was finally isolated by virtue of its slight solubility in hot acetone, and was recrystallized from benzene giving golden yellow crystals (m.p. 239–40°). Analysis, molecular weight determination and double-bond estimation show this compound to be a hydrocarbon formed from two molecules of a cholestatriene, and the formula $C_{54}H_{82}$ is assigned to it (found : C, 88·28, 88·53 ; H, 11·55, 11·65 per cent ; molec. wt. (Rast), 763, 740. $C_{54}H_{82}$ requires C, 88·71 ; H, 11·51 per cent ; mol. wt. 730). Perbenzoic acid reacts with four double bonds per molecule after twenty-four hours at 0°. Two more double bonds react after three days at room temperature, a treatment required to estimate the double bond in Δ^{9}-octalin. Thus the yellow compound is a bicholestatriene.

The position of the double bonds and the point of linkage of the two molecules can only be surmised at the present stage of the investigation. One possibility is that we have $\Delta^{4,6,8(9)}$-bicholestatriene with a 4,4′-linkage (III). This makes all six double bonds conjugated and explains the yellow colour of the compound. The other possibility is that we have $\Delta^{3,5,8(9)}$-bicholestatriene (IV) with a 7,7′-linkage. Such structure resembles the pinacol structure of the bidehydrosterols proposed by Inhoffen[4].



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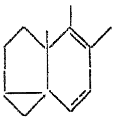

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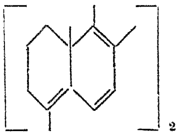
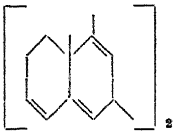


III



IV

As to the mechanism of formation, it is believed that the precursor to this compound is the monomer (II). Treatment with acid may open the *cyclo*propane ring, creating a $C_4 : C_5$ double bond in conjugation with the other two double bonds and the simultaneous 4,4′-linkage (III). On the other hand, the opening of the ring may create a $C_3 : C_4$ double bond, causing the rearrangement of the original Δ^{6} double bond and the formation of the 7,7′-linkage (IV).

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Pyrolysis of Salts of Organic Acids

CONSIDERABLE historical interest is attached to the action of heat on the salts of organic acids, and, in particular, to the formation of aldehydes by the pyrolysis of a mixture of the appropriate calcium or barium salt with the corresponding formate[1]. In the course of a wider investigation, a study of the mechanism of such reactions has been undertaken using the isotopic tracer technique, and this preliminary note reports on the formation of acetaldehyde from acetate–formate mixtures.

A sample of barium acetate, in which the carboxyl carbon was labelled with carbon-13, namely, $Ba(O_2C^{13}.CH_3)_2$, was prepared by the reaction

$$C^{13}O_2 + CH_3MgI \rightarrow CH_3C^{13}O_2MgI,$$

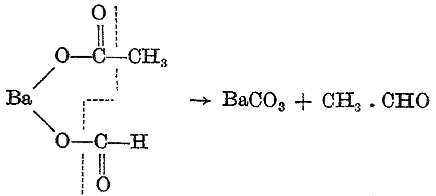
followed by treatment with mineral acid and subsequent conversion of the acetic acid to the barium salt.

The labelled barium acetate was mixed with isotopically normal barium formate and pyrolysed at 650° C. in a stream of nitrogen, the volatile products being condensed in liquid air, while the non-volatile residue of barium carbonate remained in the reaction vessel. The reaction was accompanied by the production of a small amount of tarry material which condensed on the cooler parts of the tube.

The volatile products were oxidized by chromic acid using the method of Adams and Nicholls[2] : this method, while not strictly quantitative under the conditions of the experiment, has the advantages that (*a*) it is not invalidated by the appearance of alcohols in the volatile products[3,4], and (*b*) the organic acid remaining after oxidation is acetic acid derived only from the acetaldehyde originally present. The acetaldehyde was thus estimated as acetic acid by titration with carbonate-free sodium hydroxide ; evaporation of this titrated solution yielded solid sodium acetate, which was then converted into *p*-nitrobenzyl acetate. Samples of the labelled barium acetate, the residual barium carbonate, and the *p*-nitrobenzyl acetate were converted to carbon dioxide by a wet combustion method[5] and the C^{13}/C^{12} abundance ratios determined.

Pyrolysis mixture $\frac{BaAc_2}{BaFor_2}$ (1)	% Concentration of C^{13}			
	Carbonyl carbon of $BaAc_2$ (2)	Carbonyl carbon of pyrolysis mixture (3)	Residual $BaCO_3$	
			Found (4)	Calc. (5)
0·2	5·45	1·85	2·19	2·18
1·0	2·97	2·05	2·31	2·22

The values in columns (2) and (3) of the accompanying table are calculated from the experimentally determined overall percentage of carbon-13 in the labelled barium acetate, which, by the method of synthesis, has a normal abundance of carbon-13 in the methyl group. The enhanced abundance of carbon-13 in the residual barium carbonate, shown by comparison of the figures in columns (3) and (4), indicates that the formation of acetaldehyde occurs as follows :



$$Ba\begin{cases} O-\overset{\overset{\textstyle O}{\|}}{C}-CH_3 \\ O-\underset{\underset{\textstyle O}{\|}}{C}-H \end{cases} \rightarrow BaCO_3 + CH_3 . CHO$$

The values in column (5) have been calculated from the yield of acetaldehyde determined by titration, on the basis of the scheme of reaction shown above, and making the assumption, as yet untested, that the percentage of carbon-13 in the carbonyl group of the acetone also produced is the same as that in the carboxyl group of the labelled barium acetate. Further evidence that the carboxyl carbon of the barium acetate does not appear in the acetaldehyde formed is afforded by the carbon-13 abundance in the *p*-nitrobenzyl acetate, which mass-spectrometric analysis has shown to be normal.

The fission of the C—C bond of the acetate as indicated above is probably accompanied by the formation of a free methyl radical capable of combining with a formyl or acetyl residue to give acetaldehyde or acetone respectively. A mechanism of this type, involving homolytic bond fission, would be consistent with the experimental conditions of reaction.

This work is being continued and extended to include related reactions such as ring-closure by the pyrolysis of salts of dicarboxylic acids, and the thermal decomposition of salts of organic acids other than those of the alkaline earth metals.

We are greatly indebted to Dr. A. V. Grosse, of the Houdry Process Corporation, for a gift of isotopically enriched barium carbonate, and to the Mass Spectrometer Group of the Atomic Energy Research Establishment, Harwell, for these preliminary isotopic assays.

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Nov. 14.

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Identification of Dinitrophenylamino-Acids

THE identification of the free amino-groups of proteins by the method introduced by Sanger[1] is now widely practised, its most attractive feature being the resistance of most dinitrophenyl amino-acids to acid hydrolysis. There are, however, two difficulties in the application of this technique: first, several systems of solvents are used, some of which do not dissolve the dinitrophenyl compounds very well. Secondly, chromatographic resolution of some of the derivatives is poor, the masking of the polar amino-group by the massive dinitrophenyl residue being generally disadvantageous.

In the course of the protein studies being made here, it has often been suggested that a method of regenerating the parent amino-acids from their dinitrophenyl derivatives was desirable. Paper chromatographic analysis of amino-acids is more convincing than separation of the dinitrophenyl compounds, because of the additive effect of successive treatment with two solvents. It has now been found that regeneration can usually be brought about by heating the dinitrophenyl derivatives either in acid containing hydrogen peroxide or, more conveniently, in alkali.

Heating with 2 *N* sulphuric acid containing a few drops of 100-volume hydrogen peroxide is sufficient, in most cases, to cause the dinitrophenyl compound to yield the amino-acid and dinitrophenol. This process is not well adapted to the micro-scale, however, and it has been found simpler to hydrolyse the derivative in a sealed tube with saturated baryta water. Reaction is usually complete after about one hour at 100° C., when the solution may be removed from the tube and shaken with a small piece of solid carbon dioxide. The precipitated barium carbonate can be centrifuged off, the liquor concentrated by evaporation and applied to a paper chromatogram.

All the commonly occurring amino-acids can be recovered in this way, with the exception of histidine and cystine, of which very small yields are obtained. As might be expected, dinitrophenyl–arginine gives rise to several extraneous ninhydrin-positive substances, while recovered threonine is also accompanied by an artefact. However, any confusion from this source can be overcome by a preliminary separation of the dinitrophenyl acids into groups, using the usual methods.

An interesting effect has been found when hydrolysis is carried out in alkali and hydrogen peroxide. Under these conditions certain acids, together with the dinitrophenol, are destroyed by heating for four hours. Thus, no trace can be found of alanine, phenylalanine, tyrosine or aspartic acid, although they are present after treatment for only one hour. More artefacts are produced from some compounds by this treatment; but in certain circumstances the selective destruction of some amino-acids may be useful.

An unsuccessful attempt to recover glycylglycine from its dinitrophenyl derivative has been made, but qualitative observations indicate that other peptides may show more favourable characteristics.

This technique has been applied to insulin, and the presence of glycine and phenylalanine as terminal acids clearly confirmed. Other examples of its use are now under investigation.

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Cathodic Evolution of Hydrogen at Very High Current Densities

ONE of the most critical experiments in the theory of the cathodic evolution of hydrogen[1] concerns the dependence of the reaction-rate (represented by the current density) upon the cathodic potential at very high current densities, where the metal surface approaches saturation with hydrogen. In this region a limiting current[2] would be expected if the hydrogen atom combination forms the rate-controlling reaction, or constancy of over-potential with current density would occur if (according to Hickling and Salt[3]) the mechanism involves the electrochemical discharge reaction. On the other hand, if the kinetics of the evolution depend upon proton discharge, a linearity between log i (the current density) and η (the over-potential) would be expected[4].

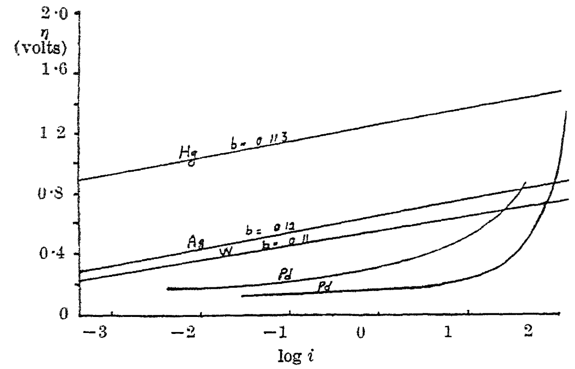

Fig. 1. Hydrogen over-potential on mercury, silver, tungsten and palladium in 5 N hydrochloric acid

No successful work on hydrogen over-potential at very high current densities (greater than 1 amp. per sq. cm.[5]) has previously been reported. In the work reported here, heating effects and concentration over-potential were eliminated by utilizing a very rapid streaming-rate (20–22 metres/sec.) of the solution over a wire electrode maintained in a constriction, and the electrode area was of the order of 0·01 sq. cm. The main difficulty, that of allowing for the ohmic drop between the cathode and the cathode tip, was overcome by making measurements simultaneously on four cathode tips at various distances from the electrode and extrapolating measured values to zero cathode-tip distance. With this arrangement it was found possible to apply the direct method of measurement up to 150 amp. per sq. cm. The measurements with the cathode tips at various distances from the cathode enabled an experimental test of the Levich theory of concentration polarization[6] to be made in the Prandtl boundary layer[7], and the theory was found to be in good agreement with experiment.

Measurements from 10^{-3} amp. per sq. cm. up to at least 100 amp. per sq. cm., and in some cases 150 amp. per sq. cm., were made on the following cathode materials: mercury, tungsten, silver, smooth platinum and palladium in 5 N aqueous hydrochloric acid solution. Nickel cathodes were also examined in 1 N aqueous hydrochloric acid solution and smooth platinum in 1 N and 10 N aqueous hydrochloric acid solution. The results for mercury, tungsten, silver and platinum are the mean of several experiments which had a mean reproducibility of ± (0·01 − 0·02) volt. Results for palladium and nickel were less reproducible, and for these metals limits of the variable results are shown. The values of the over-potential at lower current densities were in good agreement with work in more usual types of apparatus[1,8].

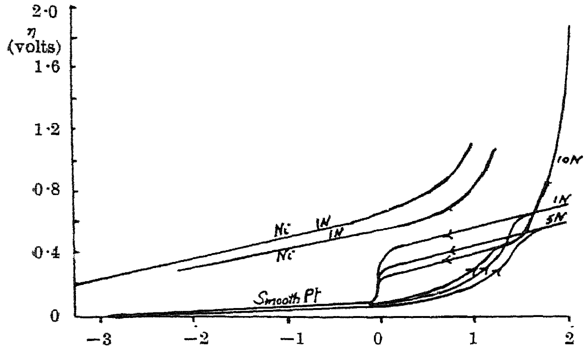

Fig. 2. Hydrogen over-potential on nickel and smooth platinum in hydrochloric acid

For mercury, tungsten and silver (see Fig. 1) the relation between η and log i was linear over the whole range of current density. For smooth platinum (see Fig. 2), a hysteresis between experiments with increasing and decreasing current densities was observed. Changes of conditions of purification of solution (including very long—four to five days—pre-electrolysis) make it unlikely that this hysteresis was caused by adsorbed impurities on the cathode surface. Diffusion of hydrogen into platinum is also an improbable cause, because similar results were not noticed with palladium (see Fig. 1).

The results for mercury, silver and platinum are contrary to those obtained with a commutator method of measurement[3]; this is not due primarily to an error in the commutator method used but to the effect of impurities in the other work.

The detailed theory of the method of measurement and significance of the results will be given in a future publication.

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Sept. 7.

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Estimation of the Hydrocarbons in Primary Tars by Hot Chromatography

Heated adsorption columns or hot solutions poured down ordinary columns have been used for the separation of the desired constituent of a mixture, mainly with the aim of accelerating what might otherwise be a tedious process. Heat can only be used where the adsorption affinities of the constituents to be separated remain sufficiently different at the higher temperature for separations to be effected.

In connexion with work undertaken on the chemical utilization of Colonial coals, it became necessary to estimate the total hydrocarbon content of a large number of primary tars. Previous methods of analysis were found unsuitable either on the grounds of their being too time-consuming or as introducing techniques, such as distillation, which were too drastic and which would have resulted in the decomposition of the hydrocarbons. Chromatography on heated columns (reduced to 'hot chromatography' for brevity) of the whole tar without any preliminary treatment was considered a method worth trying because the primary tars prepared, though very viscous at room temperature, became completely mobile at temperatures above about 40° C. A considerable proportion of benzene-insoluble material was contained in many of these tars, but this was not the same as the benzene-insoluble 'free carbon' of tars produced at higher temperatures, which, if present, might have caused blockage of the chromatographic columns. This benzene-insoluble material was of much lower carbon and higher hydrogen and oxygen contents ; it melted or went completely into solution at well below 100° C., so that the tar was effectively a single-phase system. It was thought possible, therefore, that such tars might be chromatographed hot in the same way as a mixture of liquid components, and possibly without the aid of an eluant.

The hydrocarbons were known from my previous work to consist of a mixture of saturated (white) or partly unsaturated (yellow to brown) ring compounds. Aromatic hydrocarbons were completely absent. Thus it was considered that the phenols, bases, resinous compounds (mainly esters), and acids, would remain more strongly adsorbed on the column, while the hydrocarbons would be eluted first. Experiment showed these considerations to be valid, but that an eluant was necessary to expedite the separation of the hydrocarbons. The method finally adopted was as follows.

A quantity of tar (usually about 5 gm.) was weighed by difference into a glass chromatographic tube containing a silica column, 6 in. long by ½ in. diameter. The silica gel had been previously sized between 100 and 200 B.S. sieves, and ignited at 500° C. before use ; this preliminary ignition was found necessary, as the stronger adsorbent which resulted gave a much clearer separation between the hydrocarbons and the other constituents of the tar, and enabled a shorter column to be used. About 12 in. of the central tube containing the silica was completely surrounded by a glass jacket through which steam was passed ; thus about 6 in. of the upper, unpacked portion of this central tube was also heated. The tar liquefies and passes down the column. The hydrocarbons take up their usual positions on the column below the other constituents, appearing white and yellow in white light and blue in ultraviolet light. Light petroleum (100–120°) was used as the eluant and was heated in the portion of the tube above the adsorbent. The white hydrocarbons emerge first from the column followed by the yellow hydrocarbons. The chromatography is continued until the eluant emerges colourless (three to four hours). Blockages which sometimes occur are easily cleared by slight pressure exerted at the top of the column by means of a bellows. The light petroleum is distilled off from the hydrocarbons under a water-pump vacuum (20–30 mm. mercury pressure) in a small flask (previously weighed complete with air-leak and adapter) heated by means of an oil-bath. The distillation is continued to constant weight.

The following percentages of hydrocarbons were obtained for eight determinations on the same bulk sample of tar : 53·5, 54·4, 53·0, 53·7, 53·9, 54·2, 52·5, 53·5 ; arithmetical mean, 53·6 ; maximum divergence from mean, 1·1 ; maximum divergence from mean taking best six results, 0·6.

The analyses of the hydrocarbons were the same within the limits of experimental error for carbon and hydrogen determinations. The determination can be completed in one working day, and the apparatus is usually operated in a battery of up to six columns. The method has been successfully applied to the estimation of the hydrocarbons in tars collected in the Gray–King assay of a great number of coals, particularly those which are perhydrous and of canneloid type.

The work described was carried out in the Powell Duffryn Research Laboratories, and my thanks are due to the managing director, Mr. J. G. Bennett, for permission to publish the results obtained.

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Velocity of Light

IN *Nature* of February 26, 1949, p. 338, I gave a preliminary value for the velocity of light *in vacuo* as 299,796 ± 2 km./sec.

Further determinations by means of the geodimeter were made during 1949. The apparatus has been considerably improved, and the better knowledge of its functioning has led to a change of the value for 1948 to

$$c = 299{,}793 \pm 2 \text{ km./sec.}$$

The results for 1949 are shown in the accompanying table.

Date	Base-length	Weight	Velocity	Mean
May 5	6906 m.	2	299,792 4	
8	,,	12	3 0	
9	,,	1	2 0	
10	,,	5	2·1	
11	,,	9	2 0	
13	,,	3	3 0	
14	,,	2	2·4	299,792 6±0·27
Sept. 24	6906 m.	0·5	2 3	
26	,,	2 0	3·8	
27	.	6 0	2·2	
28	,,	0·3	3·5	
29	,,	7 0	2·4	
Oct. 3	,,	9 2	2 6	299.792 6±0·30
Oct. 4	5144 m.	2 0	2 9	
5	,,	2 5	3 8	
6	,,	2·0	3 3	299,793 4±1 0
Oct. 8	1762 m.	0 5	1 8	299,791·8±2 0

The mean of the means is :

$$c = 299{,}792{\cdot}7 \pm 0{\cdot}25 \text{ km./sec.}$$

The Barrel–Sears value of the refractive index increases the above figures by 400 m./sec. The limits include the uncertainties of atmospheric conditions 0·20 cm., frequency 0·25 cm., colour 0·20 cm., base-line 0·25 cm., at the base-length of 7 km. The short lines have greater uncertainty, perhaps 1·0 cm. Of interest are Essen's[1] and Aslakson's[2] value of 299,792 km./sec.

During August (June and July are too light in the north) the lengths of two triangle sides were determined. The first one was 20 km. between two islands off the Norrland coast, the second was 31 km. between two *fjeldtops* in Lapland. The accuracy (three nights) was 1 : 450,000. The purpose of this work was to strengthen the ordinary determination, which was not highly accurate. The deviation of 1 : 100,000 was plausible.

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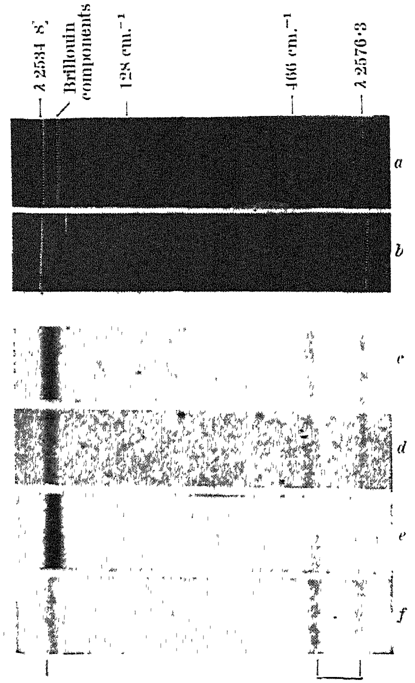
Thermal Scattering of Light in Quartz

Using the λ 2536·5 mercury resonance radiation as exciter and the medium quartz spectrograph with a fine slit, one of us[1] successfully recorded the doubling of the λ 2536·5 line in the spectrum of the light scattered by diamond, the latter itself being completely quenched by a mercury vapour filter. This doubling, as is well known, is of the nature of a Doppler effect arising from the selective reflexion of the monochromatic light by the approaching and receding sound waves of thermal origin assumed to be present in the crystal and travelling in all directions. The components are called Doppler-shifted or Brillouin components. We have now photographed the Brillouin components arising from the thermal scattering of light in quartz using the λ 2536·5 radiation from a water-cooled magnet-controlled quartz arc as exciter and a Hilger three-metre quartz spectrograph having a dispersion of 13·7 cm.$^{-1}$ in the λ 2536 region.

Fig. *a* in the accompanying illustration represents the spectrogram of the scattered light after absorption by a mercury-vapour filter kept at room temperature, taken with a slit-width of 0·01 mm. and an exposure of about one day, while Fig. *b* represents the spectrum of the direct arc. In both cases λ 2536·5 is completely suppressed. The doubling of the exciting line arising from thermal scattering is clearly visible in the spectrum of the light scattered from quartz, while in Fig. *c* the same effect is seen on an enlarged scale. Two of the most intense Raman lines of quartz, namely, 466 cm.$^{-1}$ and 128 cm.$^{-1}$, are also discernible in the scattered spectrum; they are, however, less intense and very much broader than the Brillouin components. Figs. *c*, *d*, *e* and *f* are enlarged photographs of the spectra taken for different orientations of the crystal and for different angles of scattering.



(*a*) Spectrum of the scattered light from quartz. (*b*) Spectrum of the direct arc. (*c*–*f*) Enlarged photographs of the scattered spectra for four different orientations of the crystal

As is to be expected, the separation of the Brillouin components varies with orientation of the crystal and the angle of scattering. The observed values of the Doppler shifts are in good agreement with those calculated from the known elastic constants of quartz using the well-known Brillouin formula. It may be remarked that Gross[2], working with λ 4358 radiation and a 30-step echelon spectroscope, reported having observed the Doppler components with quartz; but no such convincing experimental evidence was presented by him. Moreover, we have recorded the components without the use of an interferometer.

For any given direction in a crystal, there are, in general, three distinct sound velocities, one longitudinal and two transverse. One should, therefore, expect to observe six Doppler components, three on either side of the exciting radiation. A calculation of the intensities of the components on the basis of Müller's theory[3] shows that the components arising from transverse waves are much less intense than the longitudinal ones. It is therefore not surprising to find that in the spectrograms reproduced here only the longitudinal components have been observed. A detailed paper will be published elsewhere.

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Optics of Ethylenediamine Tartrate at Elevated Temperatures

Ethylenediamine tartrate, $C_6H_{14}N_2O_6$, prepared from tartaric acid and ethylenediamine in equimolecular proportions, is a water-soluble piezoelectric compound which crystallizes in the monoclinic system at room temperature.

A preliminary optical and X-ray examination at room temperature has been carried out with the view of studying the crystal structure. These results have recently been reported elsewhere by other workers[1] and, therefore, will not be repeated here, except to summarize data relevant to that which follows.

Specific gravity = 1·539 ± 0 001 at 18° C.
Approx. monoclinic cell dimensions a = 8 9 A.
b = 8 8 A.
c = 5 9 A.
β = 105°
Acute bisectrix = a
Extinction $a \wedge c$ = 25° in acute β
Optic axial angle 2E approx = 40°
Dispersion strong horizontal $v > r$

Crystals of ethylenediamine tartrate have now been studied with the polarizing microscope at temperatures up to the point at which melting and decomposition take place. It has been found that, as in the case of some other biaxial compounds, for example, selenite, the optic axial angle decreases with increasing temperature. In the case of ethylenediamine tartrate, the optic axial angle becomes zero at a temperature of very approximately 120° C., the crystals then being in a uniaxial negative condition. When the temperature is further increased, the biaxial negative condition is restored and the optic axial angle increases until melting and decomposition occur.

As a result of these observations, the possibility presented itself of studying the structure when in the uniaxial condition, using a high-temperature single-crystal camera[2]. The first results, however, indicated that the crystals may be too unstable, but it is hoped to continue the study.

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Polydactyly in Mice

THE genetics of polydactyly have attracted attention in a good many organisms, and in mice the pioneer researches of Fortuyn[1], Murray[2] and others have sufficed to reveal a situation of more than ordinary complexity. The first substantial step towards bringing the problem within reach of experimental elucidation was taken by Holt[3] at the Galton Laboratory at University College, London, who demonstrated that by systematic selection a strain could be constructed manifesting polydactyly in nearly 100 per cent of its members.

Last year, using a strain derived from Holt's, but containing in addition a number of recessive genes, a systematic system of matings was set in train which has now gone so far as to clear up the situation to a very large extent.

It appears from recent tests in this Department that the main factor postulated by Holt, *py*, is linked with leaden (*ln*) with a recombination fraction of probably 20-30 per cent. Since no other linkage with leaden has so far appeared, this establishes a new linkage group, to which the number XIII should be assigned, unless indeed some other contemporaneous discovery is more properly assigned to this number.

Homozygotes for *py* are not unconditionally polydactylous, but may have normal feet if one or more of a number of suppressive factors are present. One of these suppressors has been located in the Vth chromosome, between the loci of agouti and pallid. Since this short region already contains the two useful markers, undulated, *un*, and wellhaarig, *we*, we are in a very favourable position for ascertaining the position of its locus with accuracy. It is a powerful suppressor for which a single gene substitution seems to reduce the frequency of manifestation about tenfold; but more accurate estimates will be possible when it is more accurately located.

At least two other suppressors of unequal intensity have been found in my own stocks, and, of course, elsewhere there may be others. So far, however, I have no indications of linkage for these, though they have been sufficiently isolated to make systematic tests possible. The results to date are, however, enough fully to substantiate the general theory put forward by Holt.

A point of evolutionary interest is that a morphologically similar mutation is known in several species of birds, and is there found to be partially dominant, or, to put it more accurately, not completely recessive. In mice the mutant is not only completely recessive, but appears to have advanced very far in the succession of changes needed to suppress its action even in the homozygote. It is not irrelevant to this comparison that in the last hundred million years or so mouse populations and their ancestors have probably experienced three or four times as many generations as have the birds.

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Experimental Enamel Hypoplasia

IN a previous paper[1], a method was described of producing enamel hypoplasia in the rat's incisor tooth by stopping matrix formation by the tall ameloblasts. This method consisted in essentials of first causing healing of low-phosphorus rickets and then suddenly stopping healing by re-imposing the rachitic condition. This procedure stops calcification of bone[2] and dentin, but does not interfere with matrix formation in these tissues. In the case of enamel, however, matrix formation by the tall ameloblasts is stopped permanently, and these cells become temporarily seriously disoriented. The matrix and ameloblasts affected have been called the 'experimental' matrix and ameloblasts.

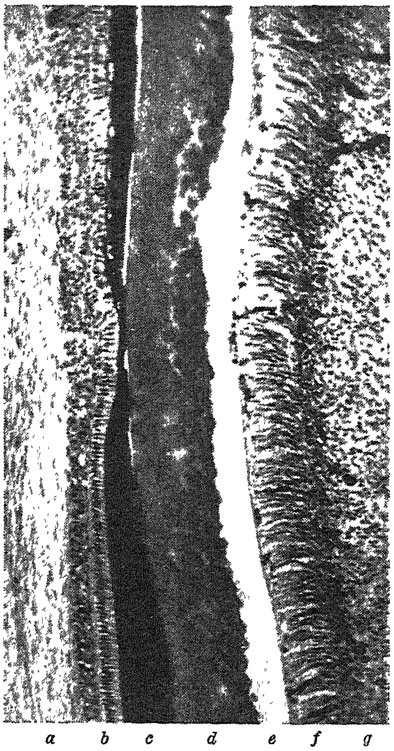
The chief disadvantage of this technique was that the ameloblasts younger than the experimental ones were often also greatly disoriented. When this happened, they laid down amorphous globular material before starting amelogenesis proper, and sometimes recovery was never seen, and very little new enamel was formed.

Further experiments were therefore undertaken to see if this post-experimental irregular amelogenesis could be stopped. Subsequent work has shown that it was due to the re-imposition of a continuous rachitic condition, probably alternating with periods of healing, since the animals usually gained very little more weight and generally went rapidly downhill after a fortnight or more. To overcome this difficulty, animals were given the full rachitogenic diet for only a short period and were then put on to the complete diet used for stock rats. The procedure may be summarized as follows:

	Treatment	Effect on amelogenesis
1	Rachitogenic diet, 28 days	Nil
2	Dietary restriction to cause healing, 6 days	Nil
3	Full feeding on the rachitogenic diet, 3 days	Cessation of matrix formation
4	Stock diet	Normal formation of new enamel matrix. No more experimental matrix formed

The second period of rickets (3 in the table) lasted long enough for amelogenesis to be stopped, but the post-experimental ameloblasts did not become disorganised. As a result, amelogenesis was invariably resumed by these cells (see photograph). About the first hundred ameloblasts, however, also contributed to the hypoplasia, as they produced matrix normal in structure but abnormally narrow. As one moved towards the formative end of the tooth, the enamel became wider and was finally of proper width. It would appear that the extent of amelogenesis by a particular ameloblast is conditioned by that of the cell ahead of it.

The experimental ameloblasts, which were very disoriented by the procedure, recovered after about eight days, but were now much shorter than before. The changes were similar in many ways to those caused by strontium injections[3]. As found by Chase[4], these ameloblasts could not completely mature or calcify the experimental matrix. This became largely



Longitudinal section (× 115) of the labial side of the upper incisor tooth of a rat which was treated in accordance with the procedure described and was killed eight days after step 4.
a, labial alveolar periosteum; *b*, enamel organ; *c*, enamel matrix; *d*, dentin; *e*, predentin; *f*, odontoblasts; *g*, pulp. The formative end of the section is at the bottom. The experimental ameloblasts have recovered as much as possible and the matrix is starting to become acid-soluble, but no new matrix has been formed. The post-experimental ameloblasts are normal and have continued to produce enamel, but the first matrix formed is abnormally narrow. Note sharp demarcation of experimental from post-experimental ameloblasts

acid-soluble; but a fine fibrous structure, consisting of the walls of the enamel rods, persisted. In spite of the findings of Lefkowitz and his colleagues[5], and of other workers, I consider that the ameloblasts play a major part in the maturation or secondary calcification of the enamel, and that the pulp is not primarily concerned.

The step in the procedure that originally stopped the experimental ameloblasts from making further matrix is the one which arrested calcification in general. The fact that this stops enamel matrix formation, but not that of bone or dentin, shows that amelogenesis is a fundamentally different process, and is probably bound up with calcification from the start. That such primary calcification of the enamel does occur has been shown by Saunders, Nuckolls and Frisbie[6], and by Weinmann, Wessinger and Reed[7].

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[7] Weinmann, J. P., Wessinger, G. D., and Reed, G., *J. Dent. Res.*, **21**, 171 (1942).

A Rapid Permanent Method for Chromosomes

THE difficulty which is usually met with in counterstaining smears and sections stained with Crystal Violet can be largely overcome by the use of 'Cellosolve' (ethylene glycol monoethyl ether) as a dehydrating agent. Crystal and Gentian Violet are considerably less soluble in 'Cellosolve' than alcohol and hence are not removed quite so rapidly from the cells. Provided that the cells are fixed sufficiently, the shrinkage caused by this fluid is negligible.

A rapid method which has proved very efficient is as follows.

(1) Fix root tips, anthers, etc., for 12–24 hr. in Navashin's fluid; (2) place root tips on a clean slide, previously coated with a thin smear of Mayer's albumen, in a drop of macerating fluid (1 part HCl/1 part alcohol 95 per cent); warm over spirit lamp about 60 sec.; (3) crush roots or anthers with a scalpel and carefully spread into a smear; (4) stain $\frac{1}{2}$–1 hr. in 1 per cent aqueous Crystal Violet; (5) rinse in water; (6) pass slides through two changes of 'Cellosolve', the first containing a trace of Light Green or Eosin, 4–5 sec. in each (when using Eosin as the counterstain it is often necessary to reduce the time to 3 sec. or less in each); (7) xylene, two changes, 10 min. in each; (8) mount in Canada balsam.

It will be noticed that the lengthy process of washing out the fixative has been omitted. This omission does not lower the quality of the results in any way, but actually assists in retaining the stain. If the counterstain is omitted from the 'Cellosolve', the rate of differentiation can be controlled under low power.

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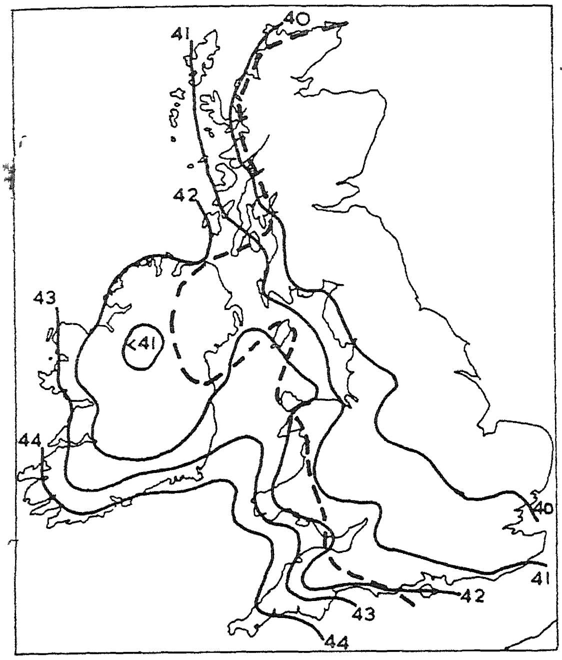
Feb. 6.

Occurrence of *Chthamalus stellatus* in the Isle of Man

IN the course of a quantitative survey of the Manx intertidal zone, the high-water barnacle, *Chthamalus stellatus* Poli, was discovered at Port St. Mary and has since been found to be generally distributed around the island. The rediscovery has been thought worth recording in view of the apparent conflict between previous accounts for the area (present: Darwin, 1854 [1], Marrat, 1886 [2]; absent: Moore and Kitching (1934), 1939 [3]), and because of the great interest in the species in its more sparse localities.

At ten stations around the Isle of Man, observations were made on the tide-levels occupied, density, and size of *Chthamalus*. The results for tide-level agree with the findings for other places near the limits of distribution of the species[3], *Chthamalus* occupying a zone above the upper *Balanus* limit (which approximates to high-water neaps plus splash zone, if any) and usually extending to 2–3 ft. above and 1 ft. below this limit. Density reached a maximum of 100–1,000 per sq. m. at about 1 ft. above high-water neaps Size, expressed as a mean of length and breadth of the shell, ranged from 4·75 mm. to 12·25 mm. In spite of the small samples measured—mostly about fifty—it appears that there is a decrease in size towards the north of the island. For example, at the Calf of Man, in the south, the mean of the



Distribution of *Chthamalus stellatus* and winter air temperature: heavy lines, isotherms of mean air temperatures (° F.) for February; broken lines, eastern limit of *Chthamalus* (modified after Moore and Kitching)

whole sample was 9·70 mm., while at Ramsey, in the north, it was 6·94 mm. This may be due to a slowing of the rate of growth in the north, possibly as a result of climatic or hydrographic factors.

The species was first noticed on September 7, 1949, and nauplii were found in a few specimens on the following day. On September 14 about 5 per cent of the Port St. Mary specimens contained nauplii; the other stations were examined between September 15 and 21, and except for one specimen on September 15, none of the *Chthamalus* contained nauplii. It is possible that all nauplii had been liberated by September 21, agreeing with the evidence from Plymouth where nauplii were found from July to September[4].

Probably the best interpretation of the previous records[1,2,3] is that in the Isle of Man, and possibly in other places near the limits of its distribution, *Chthamalus* appears and disappears from one period to another as a result of climatic or hydrographic changes; but the observations are too few to allow exact correlation. There does, however, appear to be a correlation between air temperature and the distribution of *Chthamalus* in the British Isles. If the distribution, as worked out by Moore and Kitching[3] and modified according to the present work, is compared with the mean air temperature, for example, in February[5], some correspondence can be seen between the limits of *Chthamalus* and the trend of the isotherms. It is well known that the relatively warm Atlantic water has a large influence upon winter air temperature at the coast, and thus the correspondence might be due to an Atlantic water effect on the *Chthamalus*[3]. However, in its more sparse localities *Chthamalus* is largely restricted to a zone above high-water neaps (*Balanus* limit)[3], and it has already been shown that the same zonation occurs in the Isle of Man. Ignoring at present the factors influencing this zonation, at the levels occupied the barnacles will be exposed to the air some twenty hours each day. It is therefore not unreasonable to infer that low winter air temperature may be connected in some way—either absolute level or duration—with the limitation in the distribution of *Chthamalus*. The examination of other places in the Irish Sea, where *Chthamalus* has not apparently been investigated, in particular Co. Down, Northern Ireland, and the Mull of Galloway, may give additional information bearing on this inference.

On September 16 opportunity was taken to make a hurried re-examination of the stations in Co. Antrim, Northern Ireland, mentioned by Moore and Kitching[3], with negative results; but *Balanus* itself was very sparse, so the evidence is probably not conclusive.

I am indebted to Prof. J. H. Orton, Dr. D. J. Crisp, J. R. Bruce, N. S. Jones, Dr. D. I. Williamson, and M. D. Pittam for advice and assistance in this work.

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Port Erin.
Sept. 30.

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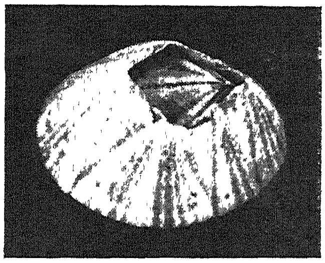
Distribution of *Balanus amphitrite* Darwin var. *denticulata* Broch

DURING the faunistic survey of the Suez Canal carried out by the Cambridge Expedition in 1924, Broch[1] found a new variety of barnacle, commonly distributed throughout the entire Canal, which he described under the name of *Balanus amphitrite* var. *denticulata*. Since Broch's original description there have been no further published records of this cirripede; but recent unpublished work on ship fouling shows that this barnacle, far from being a restricted local variety, is one of the commonest and most persistent of fouling organisms, tolerant of a wide range of temperature and salinity, and is probably the most widely distributed of all barnacles.

The species *B. amphitrite*, of which there are several varieties, is known to be widely distributed along the coasts of warm and tropical seas, extending from the Mediterranean to New Zealand[2], and I have found that Broch's variety occurs commonly throughout this wide range. Further, from data recently collected, it is clear that this variety extends considerably farther northwards than the generally accepted range of distribution for the species, and has, in fact, been a member of the marine fauna of the British south coast for a number of years at least. Thus it was found to be present in material collected by Mr. Dilwyn John in 1937 from buoys moored in the Shoreham Harbour Canal, Sussex, and that it is established at Shoreham is indicated by the settlement of several specimens on non-toxic test panels exposed in the canal during July 1947. The same variety of barnacle was also present in material given to me by the late Mr. Richard Elmhirst, collected in 1917 from a motor launch which had operated between Dover and Dunkirk. Further, in March 1948 I obtained specimens on mussel shells from Plymouth Sound, and Mr. O. D. Hunt informs me that he has occasionally collected *B. amphitrite* var. *denticulata* from local craft and test panels in the Plymouth region over a period of nearly twenty years. It seems probable that these records for southern Britain represent the limit of the northern range of distribution for the species *B. amphitrite*, where it is living at the extreme low-temperature range for successful breeding. Orton[3] quotes monthly mean sea temperature figures for Plymouth Sound (from data compiled between 1912 and 1919) which vary from a minimum of 7·8° C. in February, to a maximum of 15·9° C. in August. In this connexion it is perhaps significant that the waters of Shoreham Harbour Canal are appreciably heated by discharges of hot sea-water from an adjacent electricity works, but complete temperature data are not available.

It is clear from the work here reviewed that *B. amphitrite* var. *denticulata* is a common form of barnacle that has been overlooked by cirripede systematists for a number of years, and it is suggested that there has been confusion between this variety and Darwin's variety *communis*[4,5]. The two varieties are frequently found together in warm waters; but the latter may be readily separated by its general appearance (see photograph) and by the denticulate nature of the labrum.



Balanus amphitrite Darwin var. *denticulata* Broch. Collected from Plymouth. (× 3)

Many specimens of the variety *denticulata* have been examined from widely separate parts of the world, and these have been remarkable among barnacles for their constancy of form. No gross variation from Broch's description has been encountered, and the variety can be always readily separated from other forms of its species. Indeed, when due consideration is given to the characteristics of this barnacle, particularly to the form of the labrum, the question may be raised as to whether the variety might not qualify for specific status.

I am greatly indebted to those who have supplied me with information and material, to Mr. Charles Davidson for the photograph, and to the Marine Corrosion Sub-Committee for permission to publish this communication.

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Oct. 25.

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A Species of Fossil *Salvinia* from the Deccan Intertrappean Series, India

Two important genera discovered by the late Prof. B. Sahni in the Deccan Intertrappean cherts at Sausar and Mohgaon Kalan, Central Provinces, India, are *Sausarospermum*[1] and *Massulites*[2]. The real nature of both the genera remained obscure all these years, as it was not possible to refer them with certainty to any known living or fossil plants. Tentative comparisons, therefore, were made so as to include all possibilities concerning their nature.

The genus *Massulites* consisted of a small, round, pseudocellular mass, 170–190 μ in diameter, with microspores embedded in it, and was supposed to represent the massula of a water fern of an unknown attribution, more akin to *Salvinia* than to *Azolla*, although the possibility of its being similar to *Traquairia*, *Sporocarpon* and *Zygosporites* was not ruled out[3]. The genus *Sausarospermum* was more puzzling than the genus *Massulites* and was found in the same cherts, especially at Sausar, a taluka place near Nagpur, from which the genus derived its name. It consisted of small, oval, elliptical, seed-like bodies, 2·3 mm. × 1·4 mm., each having a peculiar frill about it, and two coatings in the midst of which was lying at the apex a beak-like projection resembling the tent pole of some Taxinæ. Sahni and Shrivastava[1], who first described these, thought them to represent the seeds of an unknown group of plants combining the characters of Gymnosperms, Pteridosperms, Caytoniales and Angiosperms. But in a later work, Sahni[4] thought it better to reserve the opinion on it, as it was very unlikely that some of the earlier groups of plants with which it was thought to be allied could have continued so late as Tertiary.

In some recent investigations made in this Department on the nature and development of the sporocarps in three species of *Salvinia*—*S. natans*, *S. cucullata* and *S. auriculata*—it was found that the adult massula in *S. auriculata* is hollow and almost identical in structure and appearance with those of *Massulites cælatus* described by Sahni and Rao[5]. This confirmed that the genus *Massulites* is really a massula of a fossil species of *Salvinia* which must have flourished in the Deccan Trap country in the Early Tertiary period. It was also observed that the megaspores of *Salvinia auriculata* and also of the other species have an ovular appearance and a beak-like projection at the apex in between the spore coats, giving them a false appearance of the seeds of gymnosperms. But by far the most characteristic feature of the megaspores of *Salvinia* is their highly vacuolized frill of perisporium exactly similar to that found in *Sausarospermum*. In addition to these features common both to the megaspores of *Salvinia* and *Sausarospermum*, it was also observed that no vascular traces of any kind were noticeable in the so-called integuments of *Sausarospermum*, clearly indicating thereby that it was rather a spore than an ovule. As it was lying in the same cherts, the conclusion that the genus *Sausarospermum* represents the megaspores of a fossil species of *Salvinia*, the microspores of which are represented by the genus *Massulites*, was irresistible. The identification of these two genera further led to the finding of the vegetative parts of the fossil species in the same cherts, and it is now possible to reconstruct the whole of the fossil species, which may appropriately be called *Salvinia intertrappea* n.sp.

Occurrence of the genus *Salvinia* in the Deccan Intertrappean Series confirms the Early Tertiary age assigned to them by the late Prof. Sahni, as previously known records of this genus are either from Tertiary or the post-Tertiary periods. It is also interesting to note that this fossil species is closely related to, but certainly not identical with, *Salvinia auriculata*, a species spread from Cuba to Brazil in South America. This reminds one of the fact that the living representatives of two other important fossil plants from the Deccan Intertrappean cherts, namely, *Cyclanthodendron*[6], related to modern Cyclanthaceæ growing in shallow waters and estuaries in Brazil, and *Rodeites*, a fossil representative of the monotypic genus *Regnellidium*[7] belonging to the Marsiliaceæ, are also from Brazil, South America. Apparently, the resemblance between the Early Tertiary flora of the Deccan and the modern flora of tropical South America is more than striking.

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Sept. 20.

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Alkaloid Tests on Herbarium Specimens

A systematic survey of Australian plants for alkaloids, begun in 1944 by the Division of Plant Industry, Commonwealth Scientific and Industrial Research Organisation, has already involved the testing of several thousand species for alkaloids and other compounds of possible chemical or pharmacological interest. Most of these tests were done in the field on fresh samples of bark, leaves, roots, wood or fruits.

For alkaloids, a simple and rapid semi-micro test, requiring about 0·1 gm. dried plant material, was devised, using conventional reagents. The precipitates were evaluated qualitatively on a + to ++++ basis, that is, traces to substantial amounts of alkaloidal substances.

The small amount of material required for these tests suggested the possibility of their application to fragments of herbarium specimens, particularly since it has proved impracticable to locate all members of promising groups in the field. Fragments from specimens in the Queensland Herbarium were kindly made available by the Government Botanist (Mr. C. T. White). These tests, which are obviously applicable only to alkaloids and alkaloidal substances which occur in leaves or branchlets, and which are stable under the conditions of preservation of herbarium specimens, have made possible a rapid screening of promising groups.

Thus, in Rutaceæ, which contains 26 genera and 117 species in Queensland, 13 genera and 32 species have been found to give good positive tests. Laboratory extractions have confirmed the presence of alkaloids in 13 of the 32 species which gave positive tests; another four have not yielded alkaloids, and the remaining fifteen species have not yet been examined in detail. In those cases (66 spp.) where tests on fresh material have also been made, the results were in good agreement with those on herbarium specimens. Where aberrations were encountered, herbarium specimens collected over the past few years usually gave better alkaloidal tests than those collected ten to fifty years ago. In other cases, however, the consistency of the results with specimens of varying age indicated the presence of very stable alkaloids. The most remarkable was *Acronychia baueri*, of which a sample collected by Alan Cunningham in 1824 gave strongly positive tests.

It is suggested, with the reservations noted above, that a reconnaissance of world alkaloid resources could be made by similarly examining specimens from various central herbaria.

Herbarium specimens are now being used to provide a complete investigation of all promising alkaloidal groups in the Queensland flora, including groups not yet encountered in the field. The results of these and other field tests, together with details of methods, will be published elsewhere.

L. J. Webb

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Nov. 7.

Indigenous *Tilia platyphyllos* in Britain

In Late-Quaternary deposits in England, pollen grains of *Tilia* have their maximum frequency, as a rule, in strata formed during the Post-Glacial climatic optimum. This fact was reported many years ago[1], and has been amply confirmed by later investigations. To the finds of *Tilia* pollen made hitherto (exclusively finds of *T. cordata*[2]) can now be added the finding by one of us (J. P. T. B.) of peat at Addington, Kent, the pollen flora of which was later investigated by Erdtman and found to contain—in its basal portions—pollen grains of *Tilia platyphyllos*. This peat bed seals an occupation site of Mesolithic age characterized by axes, gravers and microliths.

The peat samples contained pollen grains of alder, birch and hazel. There occurred, in addition, pollen grains of oak, lime (frequency about 10 per cent) and elm, together with a few stray pollen grains of holly, ivy and *Scleranthus perennis*. Spores of *Polypodium vulgare* were also present. There were no pollen grains of pine, beech and hornbeam, etc.

The above evidence favours the assumption—to be corroborated or modified by further detailed investigations—that the basal portion of the peat was formed in Neolithic times.

Several hundred lime pollen grains were investigated under high-power magnification, and it was found that about 5 per cent of them came from *T. platyphyllos*, whereas 75 per cent came from *T. cordata* and the hybrid between *T. platyphyllos* and *T. cordata*. The remaining 20 per cent of the grains could not be determined on account of partial sporoderm destruction.

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Fawke Common,
Sevenoaks, Kent.
Dec. 14.

[1] *Naturalist*, 252 (1926); *J. Bot.*, 73 (1926).

[2] *New Phytol.*, 389 (1940).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, March 13

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. B. Rensch: "The Non-Specificity of Nervous Conduction".*

INSTITUTION OF ELECTRICAL ENGINEERS, LONDON STUDENTS' SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 7 p.m.—Mr. R. C. Orford: "The Electronic Performance of Simple Mathematical Processes".

Tuesday, March 14

BRITISH PSYCHOLOGICAL SOCIETY, INDUSTRIAL SECTION (in Room 105, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 1 p.m.—Annual General Meeting: at 1.10 p.m.—Prof. P. E. Vernon: "Validation of the Civil Service Selection Board"

BIOMETRIC SOCIETY, BRITISH REGION (joint meeting with the BIOLOGICAL METHODS GROUP OF THE SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS, at the Medical Society of London, Chandos Street, Cavendish Square, London, W.1), at 2.45 p.m.—Symposium on "The Design and Evaluation of Biological Assays".

ZOOLOGICAL SOCIETY OF LONDON (at the Zoological Gardens, Regent's Park, London, N.W.8), at 5 p.m.—Scientific Papers.

ROYAL SOCIETY OF ARTS, DOMINIONS AND COLONIES SECTION (at John Adam Street, Adelphi, London, W.C.2), at 5.15 p.m.—Sir Harold Tempany: "Soil Erosion in the Colonial Empire".

INSTITUTION OF CHEMICAL ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Research Papers from Imperial and University Colleges, London, and the University of Birmingham.

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENTS SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Dr. A. Porter and Mr. F. W. Stoneman: "A New Approach to the Design of Pulse-Monitored Servo Systems".

INSTITUTION OF OFFICE MANAGERS, MERSEYSIDE BRANCH (at the Exchange Hotel, Liverpool), at 6.30 p.m.—Mr. J. W. Hendry: "Time Study as an Aid to Productivity".

MANCHESTER GEOGRAPHICAL SOCIETY (at the Geographical Hall, 16 St. Mary's Parsonage, Manchester), at 6.30 p.m.—Prof. E. G. Bowen: "Highland Britain in the Dark Ages".

SOCIETY OF CHEMICAL INDUSTRY, PLASTICS AND POLYMER GROUP (at the Royal Society of Tropical Medicine, Manson House, 26 Portland Place, London, W.1), at 6.30 p.m.—Mr. A. R. Burgess: "Degradation and Weathering of Plastics and Rubbers".

BRITISH ESPERANTIST SCIENTIFIC ASSOCIATION (in the Electrical Lecture Room, University College, Gower Street, London, W.C.1), at 7 p.m.—Dr. J. E. Holmstrom: "Internationalisation of Subject Index Heads" (in English)

INSTITUTION OF OFFICE MANAGERS, WEST MIDLAND BRANCH (at the Grand Hotel, Birmingham), at 7 p.m.—Mr. D. F. Galloway: "Production Engineering Research Association and your Production Problems".

Wednesday, March 15

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Sir Harold West: "The Thorncliffe Experiment in Employee Relationships".

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Prof. Willis Jackson: "The Structure, Electrical Properties and Applications of the Barium-Titanate Class of Ceramic Materials".

ROYAL MICROSCOPICAL SOCIETY (in the Hastings Hall, B.M.A. House, Tavistock Square, London, W.C.1), at 5.30 p.m.—Dr. G. H. Bourne: "Golgi Apparatus and Mitochondria and their Significance in Cellular Physiology".

BRITISH INSTITUTION OF RADIO ENGINEERS, NORTH-EASTERN SECTION (at Neville Hall, Westgate Road, Newcastle-upon-Tyne), at 6 p.m.—Dr. Prowse: "Electrical Breakdown of Gases at Ultra High Frequencies".

INSTITUTION OF ELECTRICAL ENGINEERS, MERSEY AND NORTH WALES CENTRE (joint meeting with the LIVERPOOL ENGINEERING SOCIETY, at The Temple, Dale Street, Liverpool), at 6 p.m.—Prof. J. M. Meek: "The Nature of the Electric Spark".

MANCHESTER METALLURGICAL SOCIETY (joint meeting with the INSTITUTE OF METALS, at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Dr. U. R. Evans, F.R.S.: "Modern Views of the Corrosion of Metals".

Thursday, March 16

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 11 a.m.—Discussion of "The Measurement of Growth and Form" (to be opened by Prof. S. Zuckerman, F.R.S.).

CHEMICAL SOCIETY, LIVERPOOL SECTION (in the Chemistry Lecture Theatre, The University, Liverpool), at 4.30 p.m.—Prof. E. K. Rideal, F.R.S.: "Heterogeneous Catalysis".

SOCIETY FOR THE PRESERVATION OF THE FAUNA OF THE EMPIRE (at the Zoological Society of London, Zoological Gardens, Regent's Park, London, N.W.8), at 4.30 p.m.—Major C. C. Wilson: A Travelogue of the Indian Jungle, mainly concerned with Capturing and Training Wild Elephants.

INSTITUTION OF MINING AND METALLURGY (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. W. M. Evans: "The Hollow Charge Effect"; Mr. Norman Hedley: "Polyphosphates in Cyanidation".

CHEMICAL SOCIETY, SHEFFIELD SECTION (joint meeting with the UNIVERSITY CHEMICAL SOCIETY, in the Chemistry Lecture Theatre, The University, Sheffield), at 5.30 p.m.—Prof. E. R. H. Jones: "Recent Developments in Acetylene Chemistry".

PHYSICAL SOCIETY, ACOUSTICS GROUP (in the Henry Jarvis Hall, Royal Institute of British Architects, 66 Portland Place, London, W.1), at 5.30 p.m.—Third Annual General Meeting; at 5.45 p.m.—Mr. P. H. Parkin: "The Transmission of Sound in Buildings".

UNIVERSITY OF LONDON (at King's College, Strand, London, W.C.2), at 5.30 p.m.—Prof. B. Segre (Bologna): "Arithmetical Questions on Algebraic Varieties".* (Further Lectures on March 17 and 21.)

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.15 p.m.—Scientific Papers.

CHEMICAL SOCIETY, EDINBURGH SECTION (joint meeting with the ROYAL INSTITUTE OF CHEMISTRY and the SOCIETY OF CHEMICAL INDUSTRY, in the North British Station Hotel, Edinburgh), at 7.3[illegible] p.m.—Dr. M. Ritchie: "Some Aspects of Photo-oxidation with reference to Chlorophyll".

BRITISH INSTITUTE OF RADIOLOGY (at 32 Welbeck Street, London, W.1), at 8.15 p.m.—"Megavoltage X-Rays".

Friday, March 17

CHEMICAL SOCIETY, BIRMINGHAM SECTION (in the Main Chemistry Lecture Theatre, The University, Edgbaston, Birmingham), at 4.30 p.m.—Prof. E. K. Rideal, F.R.S.: "How Crystals Grow".

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Annual General Meeting; Sir John Russell, F.R.S.: The Bernard Dyer Memorial Lecture.

UNIVERSITY OF LONDON (at the Institute of Archæology, Inner Circle, Regent's Park, London, N.W.1), at 5.30 p.m.—Prof. R. Pittiono (Vienna): "Prehistoric Mining in Austria—Problems and Facts".* (Further Lectures on March 20 and 21.)

BRITISH INSTITUTE OF RADIOLOGY (joint meeting with the INSTITUTE OF PHYSICS, at 32 Welbeck Street, London, W.1), at 6.30 p.m.—Symposium on "Biological Effects of Non-Ionizing Radiations with particular reference to Micro-Waves".

INSTITUTE OF PHYSICS, MANCHESTER AND DISTRICT BRANCH (in the New Physics Theatre, The University, Manchester), at 7 p.m.—Prof. W. Sucksmith, F.R.S.: "The Determination of Phase Boundaries by Magnetic Methods".

Saturday, March 18

INSTITUTION OF CHEMICAL ENGINEERS, NORTH-WESTERN BRANCH (in the Reynolds Hall, College of Technology, Manchester), at 3 p.m.—Dr. M. Ruhemann: "The Production of Technical Argon".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

GRADUATE (male, Scientific Officer grade) IN THE ANIMAL HUSBANDRY DEPARTMENT (duties will include studies in the production of grassland herbage and of its utilization under experimental and farming conditions)—The Secretary, Hannah Dairy Research Institute, Kirkhill, Ayr (March 18).

LECTURER IN CHEMISTRY—The Principal and Clerk to the Governing Body, Wigan and District Mining and Technical College, Wigan (March 18).

MEDICAL STATISTICIAN in the General Register Office—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 2968 (March 18).

SENIOR ASSISTANT responsible to the Principal for developing part-time Day and Evening Courses in chemistry, physics and related subjects, and a TEACHER OF BUILDING SCIENCE who can offer physics and chemistry for Senior and Advanced full-time and part-time Courses in building, at the College of Commerce and Technology—The Director of Education, Education Office, Sheffield 1 (March 18).

CHEMIST to join Plant Pathologist studying mineral nutrition of plants in relation to disease—The Secretary, School of Agriculture, Cambridge (March 31).

LECTURER (Grade I) IN EXPERIMENTAL THERAPEUTICS—The Secretary, The University, Birmingham 3 (March 31).

RESEARCH BIOCHEMIST to work on the biochemistry and metabolism of the eye in relation to eye disease, at the Nuffield Laboratory of Ophthalmology, Eye Hospital, Oxford—The Registrar, University Registry, Oxford (March 31).

AGRICULTURAL CHEMIST in the Colonial Agricultural Service, Kenya—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

DIRECTOR OF ENGINEERING SERVICES—The Ministry of Supply, Division of Atomic Energy (Production), Risley, near Warrington, Lancs.

DIRECTOR (Senior Principal Scientific Officer grade) OF FISH CULTURE RESEARCH AND TRAINING INSTITUTE, Penang—The Under-Secretary of State, Colonial Office, Research Department, Sanctuary Buildings, Great Smith Street, London, S.W.1.

GRADUATE CHEMIST (young) for research and development on the electro-deposition of metals and alloys—The Director, Tin Research Institute, Fraser Road, Perivale, Greenford, Middlesex.

LECTURER IN METALLURGY—The Principal, Borough Polytechnic, Borough Road, London, S.E.1.

ASSISTANT WORKS MANAGERS at Windscale Works, Sellafield, Cumberland, to be responsible to the Works Manager for (*a*) the operation of a large chemical plant handling radio-active material, or (*b*) the operation of nuclear piles, and an INSTRUMENT ENGINEER at Capenhurst Factory, near Chester, to be responsible under the Works Chief Engineer for the operation and maintenance of all electronic and industrial instruments in the Production Group—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

MAINTENANCE ENGINEER at Windscale Works, Sellafield, Cumberland, to undertake the maintenance of a large factory consisting of nuclear piles and associated chemical plant—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

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THE CHEMICAL INDUSTRY AND ITS DEVELOPMENT

THE comprehensive survey of the British chemical industry, prepared by the Association of British Chemical Manufacturers, in co-operation with other related associations, at the request of the President of the Board of Trade, is of wide and general interest; a summary of the principal features appears elsewhere in this issue (p. 420). The report claims to be the first comprehensive survey of the industry—its history and origins, its disposition and present activities and its plans for to-morrow—which has yet been published. It endeavours not only to give a clear picture of the industry itself but also of its relations with other industries, and to indicate the place it occupies as a supplier both of basic raw materials, such as soda ash and sulphuric acid, and highly finished products, such as penicillin. Quantitatively, the omission of details of expansion schemes (regarded as confidential to the Board of Trade) makes it difficult for the reader to judge how far particular sections of the industry are likely to be adequate to the part they have to play in the national economy. On the adequacy of the plans of the industry as a whole, the report leaves no doubt, and the picture of this highly complex, dynamic industry, demanding the utmost freedom of enterprise, and scientific and technical skill on a scale surpassed in no other industry, is as impressive as it is timely when the future structure of the industry of Britain is coming under political scrutiny.

The very difficulty of defining the extent of the chemical industry—the compounding of chemicals to make such products as paints, insecticides, sheep- and cattle-dips, and pharmaceutical preparations, and synthetic fibres and rayon are excluded, as is, by agreement, the tar distillation industry as such, which is to be studied by the Ministry of Fuel and Power—attests the complexity of the industry and its sensitivity to the development of new products or new routes to existing products, and the far-reaching consequences which may issue from such developments. To a limited extent this is indicated by the brief chapter on the achievements of the industry; but much is left to the imagination if one is to appreciate the full extent of the war-time achievements of the industry. Here, however, welcome emphasis is laid on the attention which the industry has given to the development of new uses for its products, and the benefits that have thereby been conferred on other industries.

The point is important, because it is by no means generally realized how development is handicapped by the preoccupation of consumers with their own difficulties, and their consequent inability to co-operate fully in assessing the value of a new product. This is a main factor obstructing the attempt of British chemical industry since the War to reduce the gap in time between discovery and its commercial application, and it is not always given full weight in discussions on that theme. Shortages of constructional materials and equipment and of technically trained staff, as well as of raw materials, including chemicals themselves, and delays arising from procedure for getting the necessary licences and permits, are other factors which hamper the industry.

On such matters the report is restrained and objective; but it seems very clear that the decisive factors may be indeed outside the orbit of the Committee on Industrial Productivity, and that Committee or the Advisory Council on Scientific Policy may be obliged to make recommendations impinging on the field of fiscal policy if outside assistance is to be given to the industry and those it immediately serves to decrease the time-gap between discovery and commercial application as compared with the corresponding gap in the United States. Elsewhere in the report the hope is expressed that plans are in operation, or at least in formulation, for eliminating all controls and permit systems no longer essential and for simplifying the machinery for applying those that remain. This is in relation to difficulties experienced in the completion and operation of the new schemes; but although the cost of replacement and extension of plant is discussed in some detail, there is no reference to taxation allowances for obsolescence, or to the suggestion sometimes canvassed that a change in fiscal policy and the basis of taxation policy would be beneficial to industrial development.

In a report dealing with an industry investing so heavily in, and so largely dependent on, research, this seems a significant omission, more especially because the report, while avoiding political issues or arguments, appears to lay much stress on the maintenance of a 'climate' favourable to enterprise and initiative and seeks to indicate the factors which promote them. It recognizes that some of the influences retarding development may be expected to disappear in time, but stresses the need for prompt authorization of new facilities for research and development, and for the granting of licences for the import of indispensable materials and equipment where these are not immediately available in Great Britain. In this connexion again, it is urged that there is a limit to the extent to which a chemical manufacturer can 'make do and mend', particularly because many plants were perforce allowed during the War to fall behind the stage of efficient maintenance. Furthermore, government departments sometimes fail to appreciate the importance of adequate facilities for maintenance.

Equally, if not more, serious than the effect on the efficiency of existing processes of the deferment of schemes for increasing research and development facilities is the long-term effect on new research and development. Time lost on research may never be regained, and the industry has already a considerable leeway to make up compared with the American manufacturer. Government departments have also discouraged the provision of additional office accommodation and amenities, even when these are essential for additional staff and work-people for the design, building, operation and control of increased production, and even when existing facilities have been condemned by His Majesty's factory inspectors. That bears particularly on another difficulty—the present scarcity of scientifically and technically trained staff. While local shortages of labour are not in general a serious problem for the industry, the scarcity of scientific and technical man-power affects every aspect of the industry's activities, and development schemes have been held up on this account and the progress of others retarded. It is the more important, therefore, that lack of office or laboratory accommodation, housing or amenities should not be allowed to hinder the most effective use being made of the services of those who are available.

There is nothing in the report to suggest that conditions in the industry are such as in any way to deter the young scientific worker or technician from entering the chemical industry. The reluctance on the part of university graduates to enter industry, to which Sir Lawrence Bragg directed attention at a British Association Conference on Science in Industry in 1945, finds no mention in this report, and the whole content of the chapter on staff and labour relations suggests that the industry has given close attention to ensuring conditions of service that attract the men it needs and, by affording them the fullest opportunity for self-expression, encourages them to give of their best. No industry recognizes more clearly that the well-being and co-operation of staff and workers are essential elements in the successful and efficient administration of complex modern industrial undertakings.

The figures relating to scientific staff are not quite complete so far as the expansion plans are concerned; hence it is not possible from this report alone to judge the full extent of the demand of the industry upon the trained man-power and woman-power of Britain. It is mainly a demand for man-power, only 253 out of a total of 6,176 scientific staff being women. The magnitude of the future demand is assessed for chemists only. On the basis of replies to a questionnaire in the autumn of 1948, about six thousand chemists were then employed for all purposes, and this was expected to increase to 8,400 by 1953, a figure demanding rather more than one-third of the total estimated by the Sub-Committee of Lord Hankey's Technical Personnel Committee as necessary to replace wastage and provide for expansion in all industry over the next five years, and one-fourth of the total demand for industry, teaching and the public service.

It should be remembered, of course, that although in some other categories of men of science the numbers involved are smaller, a shortage in them may be even more acute and have a wholly disproportionate effect on the industry. Nevertheless, the report sees no substantial advantage to be gained by co-operative research, except perhaps in connexion with chemical engineering. The industry looks rather to the fundamental work bearing on its problems continually in progress at every university and technical institution; and the report emphasizes that the industry does not lend itself to the arrangement of the research association, by reason of the number and diversity of its products and the specialization of its processes. In this connexion it is significant that the larger firms in the industry have themselves a number of research stations dealing with different branches of their activities, and clearly find it less effective to conduct their research in one central organisation. Certain sections of the industry having common problems that can be conveniently investigated by co-operative effort have, nevertheless, set up, or are organising, research associations: for example, the Coal Tar Research Association and the Paint Research Association; and firms in the industry commonly support the research associations of those industries that use its products.

Apart from this, there is no real guide in the present report as to the fundamental attitude of the industry to the research association principle in general, or whether sponsored research schemes of the pattern of those of the Mellon Institute, or the Fulmer Institute recently established in Britain, offer any advantage in the present man-power situation. There is, according to the present report, no evidence of wasteful overlap in research in the industry in the absence of a research association; and, on the contrary, it is held that some overlap is desirable, since it may lead to a healthy rivalry which acts as a stimulus to progress. It seems, therefore, that although the chemical industry sees no advantage for itself from a comprehensive research association and derives minor direct advantages from those of the industries using its products, it is not seriously concerned with the proportion of Great Britain's scientific man-power now engaged in the research associations, in spite of its own difficulties in recruiting all the scientific men and technologists it requires for expansion. Similarly, in the absence of any positive suggestions like those which Dr. W. H. Garrett recently made to the University of Liverpool Chemical Society, for improving the liaison between the universities and industry, it seems a legitimate inference that the chemical industry is reasonably satisfied with the present arrangements. Full use, moreover, is made of the research establishments of the Department of Scientific and Industrial Research, and it would seem that the chemical industry is reasonably satisfied with the general organisation of the country for scientific research.

Besides the complexity of the industry and its dependence, not only upon research, but also upon initiative and the ability to recognize and use the opportunities offered by the advance of science and technology and the constantly changing situation in regard to raw materials and the application of its products, there is one other feature that is particularly stressed in this report. Attention is directed in several places to the high cost of replacement of plant, which now amounts to about two and a half times the original cost in 1939. It follows that, besides the high proportion of scientific and technical staff to other workers, the industry is characterized by high capital investment, amounting to about £231 millions, which in terms of to-day's costs probably represents £400 millions. The schemes of replacement and expansion, to two-thirds of which the industry has already committed itself, call for roughly another £200 millions.

The need for specialized and costly plant is one of the three main reasons why economic monopolies are claimed to be an essential feature of efficient operation by the industry. The small demand for certain chemicals is another, and the technical knowledge and experience essential for some processes a third reason why many products, not protected by patent, are made exclusively or predominantly by a single firm, which may be, and frequently is, a small one. The cost of plant, and the technical control needed to obtain high yields, may make the effective operation of a process only possible if it is carried out on the largest scale justified by the demand for the product. Monopoly may be unavoidable if the scale of production adequate to achieve low production costs, and consequently the lowest selling prices, is to be secured.

One reason why the chemical industry welcomes the Monopolies and Restrictive Practices Act is the protection the Act will afford the industry against misinformed and ill-considered criticism for maintaining monopolies of this type. The report, however, points out that there is, even in these monopolies, a certain amount of protection for the general public which is inherent in the nature of the industry itself. First, the dynamic character of the industry and the extreme diversity of its products and of the choice of materials that it provides for the user industries ensure the existence of competition and provide a safeguard against abuse, quite apart from the ever-present risk of a dramatic transformation in the whole situation as a result of some new discovery. No chemical manufacturer could ever safely base his business on the retention of a 'monopoly' in certain products. The slightest suspicion of abuse of a monopoly in the industry would clearly stimulate research leading to the production of substitutes or alternatives which might well completely displace the 'monopoly'. So keenly are manufacturers aware of this that, both to avoid criticism and to deter competition, they will tend to work on narrow profit-margins and thus run less risk of attracting other manufacturers to the field. Further, where heavy capital expenditure has been incurred, the need to operate the plant to full capacity in order to secure a reasonable return upon the capital investment also tends to induce the manufacturer to stimulate demand by fixing low selling prices.

It is obvious that in this admirable report no pains have been spared to depict, accurately and faithfully, not merely the structure and achievements of the industry and its plans for the future, but also to display lucidly and frankly the conditions for the efficient operation of the industry and the factors which have determined both its present organisation and success. There can be no doubt about the immense contribution which the chemical industry can make to the economic future of Great Britain, or about the complexity and ramifications of the issues which are involved in any attempt at State control. The Association of British Chemical Manufacturers and those who co-operated in the survey on which the report is based are to be congratulated on the extent to which they have succeeded in providing the objective appreciation from which any reasonable discussion of the future of the industry must start.

STRUCTURE–ACTION RELATIONSHIPS OF DRUGS

Structure et activité pharmacodynamique des médicaments du système nerveux végétatif

Adrénaline, acétylcholine, histamine et leurs antagonistes. Par D. Bovet et F. Bovet-Nitti. Pp. 849. (Bale : S. Karger S.A., 1948.) 85 Swiss francs.

RELATIONS between the chemical constitution and the physiological action of drugs have fascinated and baffled organic chemists and pharmacologists ever since the classical work of Crum Brown and Fraser. Some authors have despaired of finding any firm relationships ; thus A. J. Clark wrote: "It may be said that there are scarcely any general rules discernible and that every cell-drug system appears to be a law unto itself". On *a priori* grounds a particularly promising field for the study of structure–action relationships should be that in which drugs impinge on physiological functions which are controlled by the liberation of the relatively simple substances, acetylcholine and adrenaline, to which *nor*adrenaline must now be added ; this is the field of study to which Dr. and Mme. Bovet have devoted themselves.

Their book deals with drugs which imitate or antagonize the effects of (1) adrenaline or stimulation of adrenergic nerves, (2) acetylcholine or stimulation of cholinergic nerves and (3) histamine ; the physiological functions of histamine are more obscure than those of the other two substances, but its liberation from cells produces dramatic effects, for the treatment of which a new group of substances has recently been discovered. The authors have themselves added greatly to our knowledge of several groups of drugs with which they deal, particularly drugs which antagonize adrenaline, curare-like drugs and anti-histamine drugs ; indeed, they seem to have had an uncanny instinct for the type of molecule which would achieve the effect they desired, and it is fascinating to trace the history of some of their achievements, for example, their development of anti-histamine drugs from compounds originally designed as antagonists of adrenaline.

The book has the rare virtue that its authors are thoroughly familiar with both the chemical and the pharmacological aspects of their subject. All too frequently structure–action relationships have been discussed by chemists who were unable to examine the pharmacological evidence critically, or by pharmacologists to whom organic chemistry was a closed book. The subject demands the closest collaboration between chemist and pharmacologist, and in recalling the history of its development several fortunate examples of collaboration leap to mind : Crum Brown and Fraser, Hunt and Renshaw, Barger and Dale, to mention only older workers in the fields with which the Bovets deal.

Another valuable feature of the book is the emphasis given to quantitative data, most of it given in tables and some of it illustrated by reproductions of kymograph tracings. The only regret that the reviewer had on laying down the book was that problems of mechanism had scarcely been mentioned. A tremendous wealth of information is presented, but, apart from a few tentative generalizations relating structure to action, this rich storehouse of factual evidence is not used as a basis for discussing how so many and varied compounds can achieve similar physiological effects.

A simple example may illustrate the point. Adrenaline is a hormone and almost certainly a chemical transmitter at some autonomic nerve endings ; it has both acidic and basic properties, but many of its effects are imitated by purely basic substances such as phenylalkylamines and even simple aliphatic amines. It is difficult (for the chemist, at any rate) to believe that effector cells which are adapted to respond to minute amounts of adrenaline, and must presumably have a special affinity for it, can respond in the same way, albeit much less actively, to purely basic amines. There is, moreover, suggestive evidence that non-phenolic amines, and even some phenolic amines like tyramine, produce their effects in a different way from catechol amines. Gaddum and Kwiatkowski were the first to suggest that some at least of the effects of ephedrine were due to it inhibiting an enzymic inactivation of adrenaline, and they produced evidence that ephedrine did, in fact, preserve adrenaline in tissues.

None of this and similar evidence is discussed, although it is mentioned. The problem of mechanism is ultimately biochemical in nature, since similar physiological effects may be produced by drugs interfering at different points in a complex cycle of biochemical events. Logically, structure–action relationships should only apply to drugs all of which produce their effects by the same mechanism, but in the present state of knowledge this is probably a counsel of perfection. It may well be that some of the baffling features of structure–action relationships, which have given rise to pessimistic views like that of Clark already quoted, will disappear as more knowledge is acquired of the intimate biochemical mechanisms of drug action.

H. R. Ing

DEVELOPMENT OF LEIBNIZ'S MATHEMATICAL IDEAS

Die Entwicklungsgeschichte der Leibnizschen Mathematik während des Aufenthaltes in Paris (1672-1676)

Von Jos. E. Hofmann. Pp. vii+252. (Munchen: Leibniz Verlag, 1949.) n.p.

ALTHOUGH this book deals only with five years of Leibniz's life, these years, spent mainly in Paris, were the decisive ones of his mathematical development. Dr. J. E. Hofmann has made a careful study of the voluminous correspondence of the mathematicians of that time and has made use of hitherto unpublished material, which is fully described.

Leibniz, born in Leipzig in 1646, received a classical, philosophical and legal education. His opportunities for gaining a knowledge of mathematics were small ; but in spite of this he composed a treatise which contained the germ of many ideas developed later. He also published a treatise on motion, of which one part was communicated to the Royal Society and the other to the Paris Academy of Sciences. However, these were spare-time occupations, for by profession Leibniz was a jurist who applied legal and philosophical principles to public affairs. The reputation he gained for this work led to his dispatch on a diplomatic mission to Paris in 1672. There he met courtiers, philosophers, men of science and charlatans, wrote political reports, and projected legal reforms.

It was the influence of Huygens that was decisive in inducing Leibniz to study mathematics seriously.

Leibniz read eagerly all the mathematical works he could obtain, and endeavoured to unify the solutions of particular problems into a general method, such as that which he devised for the summation of series.

In 1673 Leibniz spent about three months in London and attended a meeting of the Royal Society, the secretary of which, Oldenburg, was a countryman of his and had corresponded with him since 1670. Leibniz was informed by Pell that the method of summation of series had already been discovered by Regnauld and published in a book by Mouton. Thus Leibniz's lack of knowledge of current mathematical literature exposed him to a suspicion of plagiarism. On his return to Paris, Leibniz made great progress. By 1675 he had developed the symbolism and most of the elementary rules of the differential and integral calculus. Newton's fluxions had been discovered about ten years previously; but this was known only to a few friends. Dr. Hofmann gives in considerable detail the development of Leibniz's form of calculus and holds strongly that it was quite independent of the work of Newton. But he also shows how several incidents, long before the unhappy controversy over the invention of the calculus, gave rise to suspicions of plagiarism.

In 1676 a letter prepared by Collins and corrected by Newton was sent by Oldenburg to Leibniz, and gave, among other results, infinite series for logarithmic and trigonometrical functions. After only a hasty reading of this letter, Leibniz sent back a prompt answer containing what he considered his own discoveries on the subject. However, these were really essentially the same as Newton's own series. Certainly they were derived in a different way; but this was not made sufficiently clear. When the letter, addressed to Oldenburg, finally reached Newton, some time had elapsed, and Newton imagined that the letter was a carefully prepared attempt at plagiarism. On another occasion, on his second visit to England, Leibniz displayed great anxiety to read and copy the manuscripts of Newton and others entrusted to Collins, and suspicion was again aroused. Dr. Hofmann deals with these incidents very fully and concludes that Leibniz's actions were really quite innocent. However, we cannot help feeling that all this was creating an atmosphere which was destined afterwards to become poisonous.

It is not certain that Dr. Hofmann's views on controversial questions will be universally accepted; but all will be interested in the study of the evidence he produces.

H. T. H. Piaggio

FARMING IN BRITAIN THROUGH THE AGES

A History of English Farming

By Dr. C. S. Orwin. (Nelson's Agricultural Series.) Pp. vii+152+24 plates. (London and Edinburgh: Thomas Nelson and Sons, Ltd., 1949.) 8*s.* 6*d.* net.

It is widely recognized that no one can get far in the study of any subject without some knowledge of its history. This is emphatically true of agriculture, where breaks are scarce and where most things can be traced back to something that has gone before. Agriculturists fortunately possess a great classic in Lord Ernle's "English Farming, Past and Present"; but there has always been felt the need for some smaller book that would give the student a general picture in which the perspective is sound and the details, so far as they are given, accurate. Dr. C. S. Orwin's book supplies this need; in less than 150 pages he presents an account of English farm history which experts will read with pleasure and students will find most helpful.

Agriculture has been practised in Great Britain for some four thousand years; the Neolithic peoples were the first farmers, and something of their methods is now being gleaned by archæologists. By Roman times there were already tools and implements which, as Dr. Orwin says, "might be used without arousing comment by a farm worker today". Before the Norman Conquest the open-field system had developed, and of this, as might be expected, the account is full and lucid. The Black Death of 1349 intensified a change that had already begun, namely, the break-up of the old feudal system and the beginnings of independent farms, which heralded the change from subsistence farming to farming for profit with the aid of paid workers, and necessitated the enclosure of the old open fields and the consequent reduction in numbers of those having rights in land use. These changes are clearly set forth.

Then follows a section on farming in competition, showing the effects of the agricultural development of the new countries on British agriculture. The author discusses the three partners in farming: the farm worker, the farmer and the land owner. Here there is room for much controversy, but Dr. Orwin maintains a sound balance and sets out the facts clearly. He gives some remarkable instances of men who, starting in a comparatively small way, rose to very large-scale farming; such men were George Baylis, who began with 350 acres and ended up with twelve thousand acres, and Samuel Farmer, whose father had farmed 1,500 acres and who at the height of his activity was farming with his partners some twenty-five thousand acres and ended with a fortune of nearly half a million pounds. But not everyone can hope for such successes, and Dr. Orwin is somewhat pessimistic—perhaps unduly so—about farming as a career for men without capital.

Of the three partners, the land owner is nowadays probably the most handicapped in trying to discharge his duties, and some readers will think that Dr. Orwin has not given sufficient credit to the country squires for the great part they have played, and still could play but for crippling taxation, in the life of the countryside. But all who know anything about the subject will agree with his concluding sentences: "political action by the State . . . continued indefinitely can only stereotype and even sterilize the industry. History will show . . . that the advancement of agriculture is linked by unbreakable bonds with progress in the education of the farmer and research into the problems of his art." Work on these lines has been quietly going on now for some fifty years; Dr. Orwin mentions A. D. Hall, but in a future edition it is to be hoped that he will give some account of the work of the other great pioneers —T. B. Wood, Rowland Biffen, T. H. Middleton and their associates. It might be recorded, too, that Sidney Webb, one of the first Development Commissioners, was one of the stoutest supporters of the view that the Commission should foster the development of scientific research into principles rather than confine itself to finding working solutions of current problems.

The book can be cordially commended.

E. J. Russell

Klockmann's Lehrbuch der Mineralogie

Neu herausgegeben von Prof. Paul Ramdohr. Dreizehnte durchgesehene Auflage. Pp. xii+674. (Stuttgart: Ferdinand Enke, 1948.) 50 D. marks.

THIS book has become in Germany the classic exposition of mineralogical science and can be compared most directly with its American counterpart, namely, Dana's text-book published in 1932. Prof. P. Ramdohr's careful revision embodies all the advantages of a descriptive system based upon the exact measurements of the crystallographer, the chemist and the physicist. The sections on crystal form, the fine structure of crystals, the physics and chemistry of minerals and crystals, and the study of their paragenesis form an imposing prelude to the systematic description of more than twenty-five hundred mineral species.

Based upon the pioneer work of the chemist and crystallographer a century ago, these are arranged in an order that has, in its broadest aspect, undergone only comparatively minor changes during the past century. The silicates, for example, upon which so much light has been shed by the X-ray analysis of their crystal structures, can now be arranged in a manner that corresponds to their stereochemistry rather than to a series of hypothetical silicic acids. Further systematic X-ray analysis, particularly of the sulphide ores and of the lesser known sulphates and phosphates, will eventually lead to a more rational order of arrangement of the entire mineral kingdom and of related inorganic compounds.

We may expect, also, that the examination of polished ore surfaces in reflected polarized light, a method applied with outstanding success by Prof. Ramdohr in differentiating minerals and studying their order of formation and interrelations in metallic ores, will help to throw more light upon the conditions of formation of mineral veins. F. A. BANNISTER

Plants and Environment

A Textbook of Plant Autecology. By R. F. Daubenmire. Pp. xiii+424. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1947.) 36*s.* net.

THIS book is based on the author's experience of lecturing on the relation between plants and their environment to mixed groups of students, including both those whose main interest is academic and students of applied botany, and he keeps in mind the needs of the latter throughout. This has sometimes led to simplification at the expense of accuracy, as in the statement (p. 372) that "such hybridisation" (exchange of genes between ecotypes) "occasionally produces new ecotypes. Thus *Spartina Townsendii*, a natural cross between *S. stricta* and *S. alterniflora*, kills out both parents in competition. . . ."

The book includes chapters on soil, water, temperature, light, atmosphere, biotic and fire factors, followed by a short account of "The Environmental Complex" and a chapter on "Ecologic Adaptation and Evolution". The treatment is somewhat uneven. The accounts of soil, water, temperature and light are adequate, and the consideration of wind and fire as ecological factors covers ground which is often neglected. The discussion of biotic factors and the last two chapters are sketchy. A student relying solely on this book for instruction in ecology, as students of forestry and agriculture well might, would lack a realization of the importance of interaction between members of a community.

There are a number of errors in the numerical examples and a number of inaccurate statements, for example, in the discussion of *p*H (p. 45), "total number of H plus OH ions remains constant". The book is well illustrated; the diagrams of seasonal water changes in the soil are especially apt. The copy received for review had five paragraphs from pp. 345–6 repeated under a different heading on pp. 348–9. P. GREIG-SMITH

Outlines of Physical Chemistry

By Prof. Farrington Daniels. Pp. viii+713. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1948.) 40*s.* net.

THIS is a completely new version of the well-known book by Getman and Daniels, and provides an introductory course with emphasis on practical examples. A large number of problems are worked out in the text, and many more are given at the ends of the chapters, answers to some of these being provided. Some of the more elementary material has been omitted. More difficult parts of the subject are given in an appendix. Some literature references are given, together with lists of books at the ends of chapters; these are nearly all American.

The subjects dealt with are those taught in modern courses, and the standard is higher than that usually found in elementary books on the subject. Great care has been taken to make the text clear, and the numerous good illustrations are a help to the understanding. The curves are based on actual results. Modern developments are included, and, in addition to the usual topics, there are chapters on quantum theory, photochemistry, and atomic and nuclear structure. In the thermodynamics sections the American symbols and names are used.

There is little doubt that Prof. F. Daniels is right in his thesis that physical chemistry is best learnt in relation to numerical exercises, and his book is a very sound and attractive course. J. R. P.

Qualitative Analysis and Chemical Equilibrium

By Prof. T. R. Hogness and Prof. Warren C. Johnson. Third edition. Pp. xv+553. (New York: Henry Holt and Co.; London: George G. Harrap and Co., Ltd., 1947.) 18*s.*

THE authors express their indebtedness, among others, to J. Stieglitz, and this book might be briefly described as a modern form of his "Qualitative Chemical Analysis". Part 1 (285 pages) is wholly devoted to a theoretical study of chemical equilibrium and other physical concepts which are the foundations of analysis. The authors, in this edition, have amended their presentation in the light of experience and criticism, and have included the application of recently discovered principles. This section is well done and affords in simple language a clear account of modern theory.

The practical section (Part 2) describes the procedures and techniques for the analysis of mixtures containing the customary anions and cations. It has a novel feature—semi-micro methods only are used. The authors, from their experience, dilate on the advantages of these methods and predict their widespread adoption. The appendixes contain a section on mathematical operations, and various tables, including one of the physical properties of compounds usually present in mixtures for analysis. This is a most interesting book for all concerned with instructional analysis. G. F.

INTERNATIONAL AGRICULTURAL RESEARCH IN GERMANY

THE VOELKENRODE CENTRE

THERE is a great need to-day for facilities to enable research workers in agriculture from various countries to work together on the solution of urgent problems. In part, this need is being met in Britain at different research institutes and the universities. In Germany, at Voelkenrode, near Brunswick in Land Niedersachsen, a new centre for agricultural research has been developed since 1947 with the object of encouraging this type of research and "other scientific work related thereto and international co-operation in this respect".

One of the best ways of achieving a better understanding between nations lies in working together for improvement of the common good. Agriculture provides an excellent subject for such co-operation; and much might be gained from various countries pooling their resources of scientific man-power and equipment to tackle the grave problem of shrinking soil fertility, inadequate production and low-quality food.

It is symbolical that this new centre in Germany for constructive work has evolved from the great Hermann Goering Aeronautical Research Centre, where the prototypes of the *V*1 and *V*2 rockets were built for destructive warfare. The centre at Voelkenrode covers more than 1,250 acres and comprises more than forty buildings of various sizes. The first buildings were erected in 1936 after the area had been selected for aeronautical research because of its central position and excellent camouflage requirements. A purchase price of 4 million marks was paid by the Third Reich in 1944 for the land of the research centre. During the War, specialists and a staff of 1,500 employees were engaged on the following types of research: aerodynamics (including some remarkable developments in the supersonic field and the building of the largest wind-tunnel in the world—the Hermann Goering wind-tunnel); weapons research; chemistry of propellants; underground shooting tunnels, one of which was 400 metres long and constructed for complete evacuation of air; rocket and jet propulsion research.

After the War this great centre was occupied by the R.A.F., and valuable equipment was transferred to the Allies. It was the intention to destroy completely this huge research centre. However, a special plea was made by the Food and Agriculture Division of the Control Commission that those buildings which could be re-converted to "work for peace" as an agricultural research centre should be saved.

Following the recommendation of the Scientific and Technical Research Board and a letter dated March 4, 1948, from the Deputy Military Governor, the main area at Voelkenrode was handed over to the Food and Agriculture Division to be developed for peaceful research and education in agriculture. Developments since that date have been the result of good team-work in which the Economic Adviser, regional officers of Land Niedersachsen, Education Branch, Research Branch, Food, Agriculture and Forestry (British and American elements), the Foreign Office (German Section) and the German authorities have all participated.

The centre operates under the State supervision of Land Niedersachsen. The Ministry of Food, Agriculture and Forestry exercises State supervision in agreement with the Food, Agriculture and Forestry Administration of the Combined Economic Zone.

The organs of the Centre are the Board of Governors, the Senate and the Executive Committee. The Board of Governors consist of: (1) a representative of the Food, Agriculture and Forestry Administration; (2) a representative from each Land of the Combined Economic Zone, appointed by the highest Land authorities from agricultural circles; (3) three members of the Landwirtschaftlicher Forschungsrat set up for the Combined Economic Zone, who on its recommendation shall be appointed and recalled by the supervising authority; (4) four representatives of agricultural science from foreign countries.

The Senate is composed of the directors of the institutes of the Research Centre.

The Executive Committee of three includes the president of the Centre as chairman, his deputy and one other member of the Senate.

The Administration Director is responsible for the general business side of the Centre; but he is not a member of the Executive Committee or of the Senate.

The procedure for making appointments is that the Board of Governors draws up a short list of persons to fill a vacant appointment of director of an institute, and the final selection and appointment is made by the Senate subject to confirmation in office by the supervising authority.

A fundamental axiom of this Centre will be that its work is directed towards the maintenance of human freedom in thought and in action. Its structure will be decentralized, so that each institute possesses complete freedom to carry out its research programme. Any central establishment which may be developed will be run for the benefit of the community and not for any sectional interest.

A main function of the Centre is the provision of facilities for research students in Germany and from other countries. It is significant that research facilities in the Institute of Soil Biochemistry have already been provided for a research scholar from the School of Botany of the University of Cambridge, in addition to those for German personnel.

The following institutes have been set up and are in operation:

Soil Fertility Section. Soil Biochemistry: Director, Dr. W. Flaig. Humus Husbandry Research: Director, Dr. W. Sauerlandt. Soil Cultivation: Director, Dr. Fraser.

Plant Culture Section. Grassland and Crop Agronomy: Director. Prof. A. H. Koenekamp. Plant Culture and Seed Production: Director, Prof. W. Schulze.

Animal Management Section. Animal Nutrition: Director, Prof. K. Richter. Animal Constitution: Director, Prof. W. Zorn (situated at Grub, near Munich).

Economics and Sociology Section. Agricultural Market Research: Director, Dr. Arthur Hanau.

Agricultural Engineering Section. Fundamental Research in Agricultural Engineering: Director, Prof. W. Kloth. Tractor Research: Director, H. Meyer. Agricultural Machinery: Director: Dr. Brenner.

An Institute of General Farm Management is being planned as the twelfth institute of the Centre under the Economics and Sociology Section.

The statute which legalized the setting up of the Forschungsanstalt für Landwirtschaft as a corporation under public law was passed by the Cabinet of Land Niedersachsen in the latter part of 1949.

The Senate came into being officially on September 26, 1949, and the following positions were filled by election: President: Dr. Arthur Hanau; Vice-President: Prof. W. Schulze; Executive Committee: President, Vice-President and Prof. W. Kloth.

An area of 360 acres of the former airfield was developed for agricultural and experimental purposes during 1948, in spite of great shortages of equipment and numerous difficulties. Excellent results were obtained with all crops. Recently the Hornsen Estate, which consists of 618 acres, has been acquired for experimental purposes.

In this age, which may become known in history as the international age, marking as it does in the course of human evolution the gradual transition from rather isolated national to co-operative international endeavour, there is something significant in the setting-up of a new centre at Voelkenrode in Germany to assist co-operative research in agriculture. Agriculture has, in fact, a great role to take in providing a solid foundation for developing trust and understanding between various nations. It is our greatest industry: the fundamental basis of every country, great or small, temperate, sub-tropical or tropical. Primary and secondary industry are complementary and, in the future, as agriculture receives greater recognition and support as an essential medium for providing a balanced and flexible integration of primary and secondary industry, its importance will be greatly enhanced.

The tremendous potentialities of agriculture both as a means of supplying food to man and to animals, and as a source of raw materials for processing by secondary industry, have as yet received inadequate inquiry, support and research.

Much of the unrest, unemployment, poverty and shortages of food which have occurred since the Industrial Revolution can be traced to a grave underestimate of this basic and complementary value of agriculture. Unfortunately, it is true that much loss of valuable, or rather invaluable, top soil has occurred as a result of man's unscientific exploitation of Nature's reserves carried out under the name of agriculture; and perhaps our greatest problem of to-day and to-morrow lies in the prevention of such large-scale destruction by a world-wide development of soil conservation, and in building up soil fertility.

It is in this setting that the new centre at Voelkenrode has begun its great task. Germany has created an example of international co-operation in agriculture by arranging that the Board of Governors at this Centre shall include four representatives of agricultural science from foreign countries in addition to twelve German nominees. Voelkenrode has many well-wishers for its future success, not only in Germany but also in foreign countries.

Visitors have already been to Voelkenrode from the following countries: Australia, Denmark, Great Britain, the Netherlands, Sweden, South Africa and the United States. Dr. A. H. Boerma, European regional representative of the Food and Agriculture Organisation, visited Voelkenrode in September 1949 and met the directors of the different institutes. At a subsequent meeting of the Committee on Agricultural Technology, Dr. Boerma circulated a paper on Voelkenrode and on the activities being pursued there. The representatives of the various member governments of the Food and Agriculture Organisation present took note of the information and indicated their willingness to establish contacts with the institutes at Voelkenrode. It is of interest and indicative of the co-operative nature of the work at Voelkenrode that facilities are provided for German and foreign visitors in a well-equipped hostel possessing first-class accommodation, and it is intended that a guest house shall be opened in the near future.

It is hoped that this great venture will prove of assistance as a means of reaching a better understanding between the peoples of various nations, based on co-operative work for the benefit of all.

J. L. SCHOFIELD

CHEMICAL INDUSTRY OF GREAT BRITAIN

THE report on the present position of the chemical industry of Great Britain*, prepared by the Association of British Chemical Manufacturers in co-operation with the British Colour Makers' Association, the British Sulphate of Ammonia Federation, Ltd., the National Sulphuric Acid Association, Ltd., British Plastics Federation and the Superphosphate Manufacturers' Association, Ltd., is the result of an inquiry into the adequacy of the plans of the British chemical industry for the part it has to play in the national economy. The details of the expansion proposals supplied by individual firms are omitted from the report as confidential to the Board of Trade. Although therefore, from this report as published, it is scarcely possible to give a full answer to that question, the omission of such details does not affect the picture of general trends. The report is likely to be of permanent value for the comprehensive survey it gives of a most complex industry, or series of related industries, and of the factors upon which the development and efficiency of the industry depend.

The first chapter indicates the definition of the chemical industry adopted for the purpose of the survey, after discussion with the President of the Board of Trade. Heavy chemicals, industrial gases, fertilizers, dyestuffs, medicinals and other fine chemicals, explosives, plastics and other synthetic resins are included, but not the compounding of chemicals to make such products as paints, insecticides, sheep- and cattle-dips and pharmaceutical preparations. Synthetic fibres and rayon are excluded, but the chemical raw materials used in their manufacture are considered. A brief sketch of the historical background follows, with two chapters dealing successfully with such changes in the industry as are due to chemical research, the effects of plastics, the use of X-rays and biological advances, and a concise review of some achievements of the industry since the First World War. The industry's products are next described in seventeen groups, with a note on their inter-relationships. The supply of raw materials is reviewed in the following chapter, according to whether sufficient domestic supplies are available or whether supplies are drawn partly or wholly from overseas.

The most important natural resource of British industry is coal, which in the chemical industry is being used with satisfactory efficiency, although continuous study is given to new processes and power-generating systems that may make even better use of so valuable a raw material. Proposals for a more extended use of hydro-electric power in the electrochemical and electro-metallurgical industries, particularly in the Highlands of Scotland, have been studied with care; but it is concluded that Scottish hydro-electric power could not be used economically for chemical manufacture unless it were supplied at preferential rates. Under present conditions, in the United Kingdom sufficient tar is being produced to supply most of the raw materials needed for chemical manufacture, and the new plant being erected for the manufacture of synthetic phenol should make further imports of phenol unnecessary. Any drastic change in the method of carbonization of coal may, however, have wide repercussions on the whole chemical industry; but, since the same basic chemicals will become increasingly available from some new oil-cracking plants, future prospects give no real cause for anxiety. The greatly increased interest in the chemistry of acetylene may lead to a substantial increase in the demand for carbide, but development in Britain of alternative processes for acetylene is regarded as a long-term project because of the heavy list of capital commitments to which the industry is already pledged.

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* Association of British Chemical Manufacturers. Report on the Chemical Industry, 1949. Pp. 76. (London: Association of British Chemical Manufacturers, 1950.) 5s.

Of raw materials coming partly from abroad, sulphur, pyrites and zincblende are of importance as sources of sulphur for sulphuric acid, supplying 47·4 per cent, 21·5 per cent and 8·5 per cent, respectively, of the output, spent oxide accounting for a further 16·5 per cent of the 543,305 tons required annually (as sulphur). In addition, about 100,000 tons of sulphur is required for other purposes. To reduce demands for imported sulphur, attempts are being made to devise a new way of making soluble phosphates without the use of sulphuric acid. Developments in the cracking of petroleum to yield relatively cheap reactive hydrocarbons are likely to have a great influence on the organic chemical industry as a whole, and particularly in the field of synthetic plastics and resins, and several large companies are embarking on special cracking processes to give high proportions of such hydrocarbons.

A chapter on research, development and technical service points out that in no industry is the importance of research and development so well appreciated. The chemical industry has little interest in the hard-and-fast line which some have attempted to draw between pure and applied research. Research, in the industry, has three objects: the discovery of new chemicals or new physical forms of old ones likely to be of use to the industry or the general public; the discovery of the most efficient means of producing chemicals and their translation to manufacture; and the discovery of the most efficient means of using these chemicals. The importance of technical service in both the export trade and the home market is stressed, and also the encouragement given by the industry to scientific publication. There is no evidence of any considerable overlap in research beyond that which is desirable; but while the industry gives generous support to fundamental research in the universities, it does not lend itself to the arrangement of a comprehensive research association. It is estimated that the industry employs on research and development 10,100 persons, including 3,000 professionally qualified scientific workers, and that the annual expenditure of £8,500,000 will rise to £11,400,000 when expansion schemes, which now number more than two hundred, are completed. Of the £8,300,000 of additional capital expenditure involved, £1,560,000 has already been spent.

In the following chapter, on process development and plant, reference is made to research on unit processes and to the need for giving every possible encouragement to British instrument makers in their efforts to produce designs comparing favourably with those from other countries. A chart giving the cost indexes for the construction of chemical plants shows that the cost of replacing plant constructed before the War is to-day almost two and a half times the original cost. This point is again stressed in the next chapter, on patents and monopoly, as one of three reasons why economic monopolies are an essential feature of efficient operation of the industry. The report emphasizes that there are often alternative materials available to users, and that monopoly in a chemical product does not necessarily mean absence of competition. A second factor is the lively sense of manufacturers of the dangers attached to a monopoly that may attract not only criticism but also the envious eyes of a competitor. It is recognized that price agreements can give rise to dangers through groups of manufacturers being less sensitive than the individual manufacturer to either criticism or competition; and the report welcomes the Monopolies and Restrictive Practices Act not only because it will protect the public against any undesirable restrictive practices by the industry, but also the industry itself against misinformed or ill-considered criticism for maintaining just those monopolies that are an essential feature of efficiency and productivity.

The location of factories, and staff and labour relations, are discussed in the next two chapters, in which the total number of employees is given as 116,569 men and 25,248 women. The scientific staff numbers 6,176 with 33,581 other administrative, technical, clerical and sales employees, of whom 12,671 are women. Works councils exist for 89 per cent of the labour in the industry, joint production committees for 78 per cent, education schemes for 90 per cent, training schemes for 79 per cent, superannuation schemes for 73 per cent, medical schemes for 86 per cent and safety schemes for 91 per cent. As evidence that the productivity of the industry is increasing, the report cites the rise in the industry's prices of only 56 per cent during the decade 1938–48, and an increase of less than half this in the price of one of its most important products, in comparison with a general rise of 124 per cent in wholesale prices. A review of future trends and expansion, from which details confidential to the Board of Trade are omitted, indicates that fruition of all the schemes, representing a total expenditure of some £200 millions and an increase of 25,000 in employees, will increase the potential annual productivity capacity of the industry by 70 per cent in terms of value. The most serious difficulty in the completion and operation of these new schemes appears to be the present scarcity of scientific and technically trained staff. Replies to a questionnaire from the Association of British Chemical Manufacturers to its members in the autumn of 1948 suggested that a 40 per cent increase in the total of 6,000 chemists then employed by the industry was likely to be required by 1953. Physicists, pharmacologists, biologists, microbiologists and mathematicians are also required, and it seems probable that for many years to come the industry could absorb more than its share of the scientific workers and technologists that the teaching institutions of Britain can supply.

Discussing in conclusion the future of the industry, the report directs attention to the marked increase in the ratio both of new capital and of new production capacity to man-power represented by the new schemes, and estimates that in 1951 the output of the industry should be 50 per cent greater than in 1946. On completion of the expansion schemes, a reduction of imports by £28 millions is forecast by the manufacturers; but this is regarded as too high, as is the estimate of a £49 millions increase in exports (including plastics). Nevertheless, on the assumption that the plans of the industry for rehabilitation and expansion are accomplished promptly, and subject to certain reservations about sulphuric acid, it is believed that, so far as can be foreseen, the industry will prove able to meet not only the full needs of the home market, but also to eliminate avoidable chemical imports and provide a large increase in exports. It is unlikely that the expenditure on research is exceeded in any other industry in Great Britain, and the figure compares well with corresponding figures in other countries, such as the United States. The report maintains that there is evidence that the industry has within itself the resources, vigour and foresight to meet the foreseeable future and also to maintain its position in the longer term. In conclusion, it is urged that in this immensely complicated industry or series of industries, which is so often a continuous adventure into the unknown, the national interest will best be served by the utmost freedom of enterprise.

ORIGIN OF THE FLUCTUATIONS IN THE INTENSITY OF RADIO WAVES FROM GALACTIC SOURCES

Cambridge Observations

THE discovery by Hey, Parsons and Phillips[1] of a variable component of the radio emission from the constellation of Cygnus suggested that at least part of the galactic radiation was due to discrete sources of small angular diameter. Later observations by Bolton and Stanley[2] and by Ryle and Smith[3] showed that the source subtended an angle of less than 8 minutes of arc. Ryle[4] has summarized the evidence concerning the nature of the sources, and has shown that if the observed fluctuations are due to variations of the emission from the source, and are not the result of some diffraction mechanism in the earth's atmosphere, it is possible to deduce the maximum physical dimensions of the source from the observed period of the fluctuations. It is therefore of importance to determine whether the observed fluctuations are caused by some relatively local diffraction mechanism, or whether they represent genuine variations of the emission from the source.

In a private communication, Dr. J. L. Pawsey has described some experiments by Bolton, in which the source in Cygnus was observed simultaneously from sites in Australia and New Zealand. The records of fluctuations obtained in these experiments were markedly different at the two sites, and therefore suggested a comparatively local origin. In these experiments, however, the observations were made when the angle of elevation of the source was small; the radiation was therefore incident on the ionosphere and troposphere at a rather large angle. Since it was possible that the refraction effects in those experiments might cause fluctuations sufficiently large to mask any genuine variations of the incident radiation, it was decided to repeat the experiment using an observing technique which permitted observation of the source with a relatively much smaller angle of incidence (12°), for which the refraction effects should be greatly reduced. It was also possible to make similar observations of the other intense source in the constellation of Cassiopeia, which had been found in previous experiments to be relatively less disturbed.

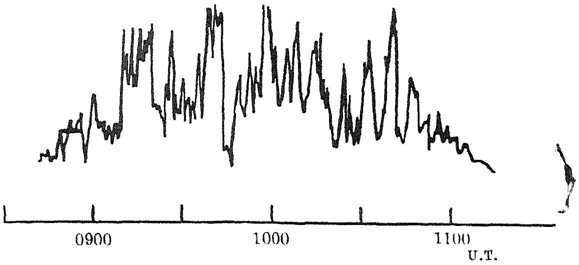

Fig 1. Fluctuations in the radiation from the source in Cassiopeia on a wave-length of 6·7 m.; October 27, 1949

Two series of experiments have therefore been carried out; the first of these was done in conjunction with Little and Lovell, and involved simultaneous observations on a wave-length of 3·7 m., using receivers at Cambridge and Jodrell Bank, Cheshire (separation 210 km.). A detailed account of these observations is given in the following communication from Little and Lovell; but no detailed correlation between the rapid fluctuations of intensity at the two receivers was found.

The second series of observations was made by the Cambridge workers on a wave-length of 6·7 m., using spacings of up to 170 km. In these observations two types of fluctuations were found.

(1) On many nights, rapid fluctuations similar to those on a wave-length of 3·7 m. were observed; no detailed correlation was found when the receivers were separated by more than 20 km. A typical record of this type of fluctuation is shown in Fig. 1. Observations on both 3·7 m. and 6·7 m. have shown that this type of fluctuation involves variations of the intensity both above and below the mean value. This observation suggests strongly that diffraction, such as might be caused in the ionosphere, is responsible for the disturbances, although there are two difficulties in such an explanation. First, it has been found that simultaneous observations at Cambridge on 3·7 m. and 6·7 m. often show considerable cor-

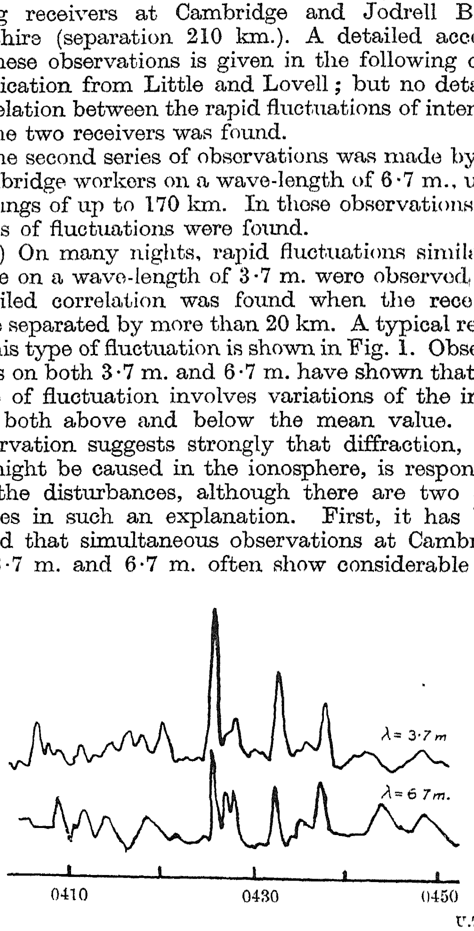

Fig. 2. Fluctuations in the radiation from the source in Cassiopeia, showing correlation between wave-lengths of 3·7 m. and 6·7 m.; July 4, 1949

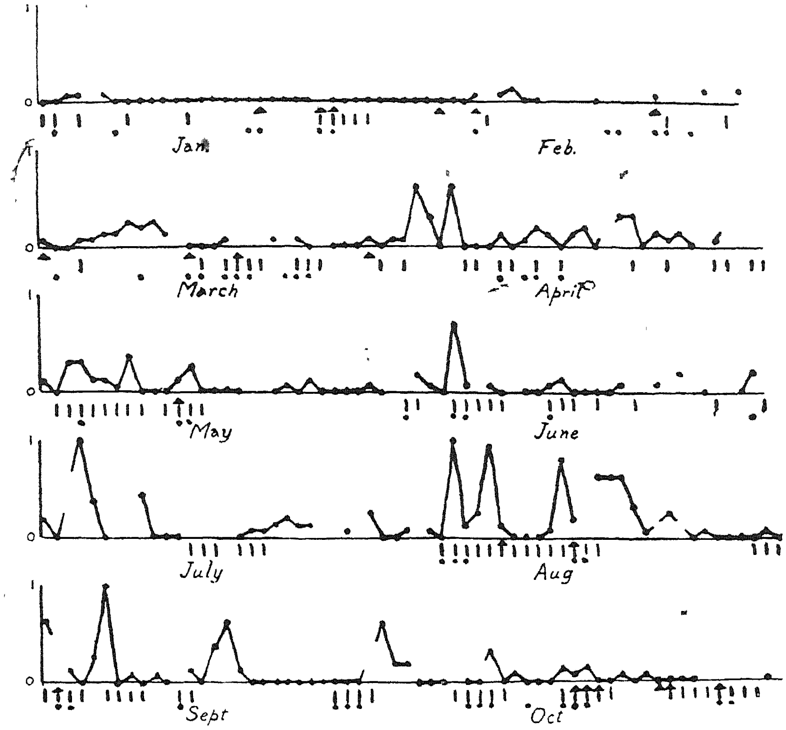

Fig. 3. Intensity of fluctuations expressed as a fraction of the mean intensity (average for the sources in Cygnus and Cassiopeia). ▲—▲—, Auroras; ▮—▮—, ionospheric storms, ●—●—, magnetic storms

relation (Fig. 2); any simple diffraction mechanism would be expected to show markedly different patterns on two such widely separated wave-lengths. Secondly, the results obtained in a series of observations on 3·7 m. over a period of ten months have shown little correlation with periods when the ionosphere was known to be disturbed. The amplitude of the fluctuations is shown in Fig. 3, together with the occurrence of ionospheric and magnetic storms and auroras.

(2) Occasionally a different type of fluctuation was observed on a wave-length of 6·7 m., which had the appearance of individual 'bursts' of large amplitude and of duration 10–20 sec. Fluctuations of this type were found to show good correlation at even widely spaced receiving sites. Fig. 4 shows simultaneous records obtained with a spacing of 160 km. This type of fluctuation was comparatively rare during the period of the observations, and it was therefore not possible to relate with certainty the direction of origin of the 'bursts' with that of either of the major sources; in view of the large spacing between the receivers, it does not appear likely, however, that the fluctuations could be of terrestrial origin, and the observations suggest that they represent genuine variations of the emission from the galactic sources.

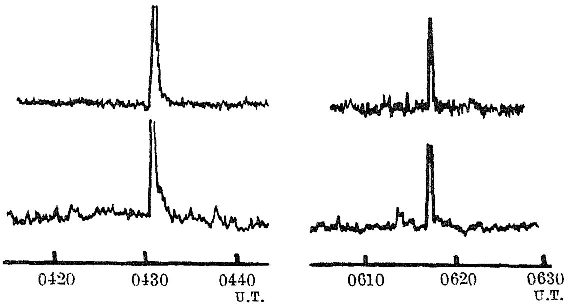

Fig. 4. Simultaneous records obtained on a wave-length of 6·7 m., with receivers separated by a distance of 160 km. Top traces, Cambridge; lower traces, Defford (Worcester)

It therefore seems likely that two separate mechanisms are responsible for the observed fluctuations. One appears to be related to variations of the emission from the sources; the brief duration of these 'bursts' suggests that the sources are of stellar dimensions. The other appears to be due to diffraction in a comparatively local region. Further experiments are necessary to confirm both these conclusions.

I should like to express my thanks to Mr. M. Ryle for his advice and help throughout this work, to Messrs. K. E. Machin and B. Elsmore for assistance in making the observations, and to Dr. N. A. de Bruyne, of Aero Research, Ltd., the Chief Superintendent of the Telecommunications Research Establishment, Malvern, and the Officer Commanding, R.A.F., Defford, for facilities in carrying out the spaced receiver observations. The work is part of a programme of research at the Cavendish Laboratory supported by the Department of Scientific and Industrial Research.

F. G. Smith

Cavendish Laboratory,
Cambridge.
Dec. 9.

[1] Hey, J. S., Parsons, S. J., and Phillips, J. W., *Nature*, **158**, 234 (1946).
[2] Bolton, J. G., and Stanley, G. J., *Nature*, **161**, 312 (1948).
[3] Ryle, M., and Smith, F. G., *Nature*, **162**, 462 (1948).
[4] Ryle, M., *Proc. Phys. Soc.*, A, **62**, 491 (1949).

Jodrell Bank Observations

The existence of intense sources of radio-frequency radiation in the constellations of Cygnus and Cassiopeia has been established by the measurements of Bolton and Stanley[1], and Ryle and Smith[2]. The existence of the source in Cygnus had been inferred previously by Hey, Parsons and Phillips[3] on account of the short-period fluctuations in intensity often shown by the radiation from the locality. Afterwards the source in Cassiopeia was also found to fluctuate[2], and it has been generally assumed that this variability is inherent in the source of radiation. Reasons for suspecting this assumption have been given by Smith in the accompanying communication.

In an attempt to settle this question unambiguously, a series of measurements of the radiation from the sources in Cygnus and Cassiopeia have been made in co-operation with Smith between May 1, 1949, and October 31, 1949. In this work the radiation from the

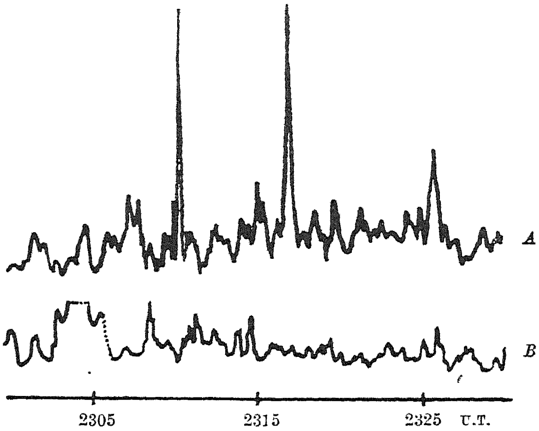

Fig. 1. Section from Cygnus transit, August 3, 1949. *A*, at Cambridge; *B*, at Jodrell Bank

sources was observed simultaneously during the transit of Cygnus and Cassiopeia at Cambridge and Jodrell Bank, Cheshire (a separation of 210 km.), using similar recording apparatus and working on a wave-length of 3·7 metres. The results of this combined work may be summarized as follows.

(1) Table 1 shows that the radiation is generally *either* steady at both sites *or* fluctuating at both sites on a given night. There are approximately 10 per cent significant exceptions when the sources fluctuate at one site but not at the other.

TABLE 1. COMPARISON OF FLUCTUATIONS ON TWO RECEIVERS SPACED 210 KM APART

Source	No. of nights of simultaneous observations	No. steady at both sites	No. fluctuating at both sites	Fluctuating at Jodrell Bank only	Fluctuating at Cambridge only
Cygnus	94	61 (65%)	25 (27%)	5 (5%)	3 (3%)
Cassiopeia	66	43 (65%)	13 (20%)	8 (12%)	2 (3%)

(2) On the occasions when the sources show fluctuations at both sites, there is no correlation between the disturbances. This is illustrated in Fig. 1, which shows the simultaneous observations of the Cygnus source during transit at Cambridge and Jodrell Bank on August 3, 1949.

It is therefore evident that the origin of these fluctuations does not lie in the galactic sources but must be situated either in the terrestrial atmosphere or the interstellar medium. Table 2 shows that whatever mechanism is responsible, generally, but not invariably, affects both sources.

TABLE 2. COMPARISON OF THE OCCURRENCE OF FLUCTUATIONS FROM BOTH SOURCES ON THE SAME NIGHT

Site	No. of nights when *both* sources were observed at transit	No. when both sources steady	No. when both sources fluctuate	No. when Cygnus only fluctuates	No. when Cassiopeia only fluctuates
Jodrell Bank	82	48 (59%)	19 (23%)	9 (11%)	6 (7%)
Cambridge	144	81 (56%)	32 (22%)	18 (13%)	13 (9%)

A further series of simultaneous observations has been made on 3·7 metres, using two receiving sets in the neighbourhood of Jodrell Bank in an attempt to establish the amount of correlation over short distances. The results are as follows:

(*a*) With similar equipments separated on a base line of 100 metres, there is complete correlation between the fluctuations.

(*b*) Over a base-line of 3·9 km. the correlation is not complete but remains high with a correlation factor varying between 0·5 and 0·95. An example is given in Fig. 2 which shows the simultaneous observations during the transit of the Cassiopeia source.

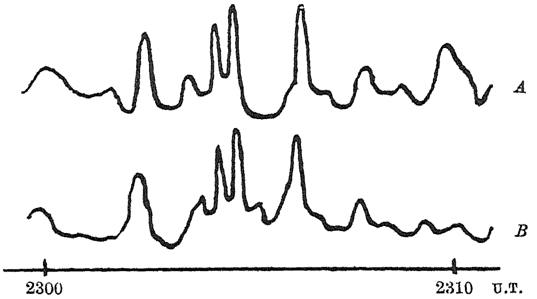

Fig. 2. Section from Cassiopeia transit, October 9, 1949. *A*, 3·9 km. south of Jodrell Bank (lat. 53° 12′ 0″ N.; long. 2° 18′ 1″ W.); *B*, at Jodrell Bank (lat. 53° 14′ 2″ N.; long. 2° 18′ 12″ W.)

This last result indicates that the origin of the fluctuations must be fairly local, and probably lies in the earth's atmosphere or ionosphere rather than in the interstellar medium. Simple considerations of the Fresnel zone theory indicate that the reversal of phase of an appreciable fraction of a zone due to localized changes in the refractive index of the ionosphere could cause fluctuations of the type observed. For example, a localized cloud of electrons 1 km. in depth in the *F*-region with a density of less than twice normal would cause a complete phase reversal. Localized disturbances in the F_2-region, with differing ionization densities and gradients, have been shown to exist by Gipps, Gipps and Venton[4]. If such a mechanism is responsible for the fluctuations, then the effect may be expected to increase in prominence with increasing angle of incidence and to show some correlation with abnormal ionospheric events.

It therefore seems likely that these fluctuations in the received intensity of the radio waves from the galactic sources are introduced in a local terrestrial medium, and are analogous to the twinkling of stars on optical wave-lengths.

We wish to thank Mr. A. Maxwell for help in taking the observations, and the Department of Scientific and Industrial Research for the financial aid given for the development of the work at Jodrell Bank. One of us (C. G. L.) is also indebted to the Department of Scientific and Industrial Research for the award of a maintenance grant during the course of this work.

C. G. LITTLE
A. C. B. LOVELL

University of Manchester.
Nov. 30.

[1] Bolton, J. G., and Stanley, G. J., *Nature*, **161**, 312 (1948).
[2] Ryle, M., and Smith, F. G., *Nature*, **162**, 462 (1948).
[3] Hey, J. S., Parsons, S. J., and Phillips, J. W., *Nature*, **158**, 234 (1946).
[4] Gipps, G. de V., Gipps, D. I., and Venton, H. R., *J. Council Sci. and Ind. Res.* (*Australia*), **21**, 215 (1948).

OBITUARIES

Dr. R. H. Rastall

Robert Heron Rastall, who died on February 3 at the age of seventy-eight, was the son of H. A. H. Rastall, of Turnerdale Hall, near Whitby. In early life he was destined for a career in agricultural science, and after taking the diploma of the Royal Agricultural Society held a post on the staff of the Tamworth Agricultural College. In 1899 he went up to Christ's College, Cambridge, where he gained a first class in both parts of the Natural Sciences Tripos, specializing in geology in Part 2, and in 1903 was awarded the Harkness Scholarship for geology. During 1906–13 he was a fellow of Christ's College and in 1926 was re-elected a supernumerary fellow. In 1910 he became University demonstrator in geology and in 1919 was appointed lecturer in economic geology. He was an active member of both the Geological and Mineralogical Societies and served on the councils of both these bodies.

Dr. Rastall's scientific interests were mainly in petrology and structural geology, and between 1903 and 1914 he worked in the Lake District and in South Africa, publishing important papers on the Ennerdale granophyre, the metamorphism of the rocks around the Skiddaw granite and the Worcester District in the Cape Province; meanwhile he was engaged in the study of sedimentary petrology and the geological structure of south-eastern England. In 1911, in collaboration with Philip Lake, he published his "Text-Book of Geology" and later several other books: "Agricultural Geology", "The Geology of the Metalliferous Deposits", and "Physico-Chemical Geology". During the First World War he held a post in the War Office and, becoming impressed with the importance of economic geology, he began to apply petrological ideas to the theory of ore deposits, writing several papers and the book referred to above. In 1916 he began to assist Henry Woodward in editing the *Geological Magazine* and, in 1919, became editor, contributing many papers to its pages. In 1934 Dr. Bulman became joint editor, and this partnership lasted until his death. Meanwhile, he had been geological editor of the 1929 edition of the "Encyclopædia Britannica", to which he contributed a number of articles. About the beginning of the Second World War he retired from Cambridge to his old home at Ruswarp near Whitby and, in collaboration with Dr. J. E. Hemingway, continued to work on the Jurassic rocks. A number of papers were published, and he remained actively interested in this work until his death.

Though of a somewhat retiring disposition, Rastall was an inspiring teacher. He was known to generations of undergraduates for his help in the Sedgwick Museum; but it was in the more intimate relation of a supervisor that he will best be remembered by many. He had the gift of drawing out and developing his pupils' ideas; a quiet talk with him could always be relied upon to produce some new and interesting point of view, and he has left a lasting mark on the Cambridge school of geology.

W. H. Wilcockson

We regret to announce the following deaths:

M. Denis Brocq-Rousseu, *correspondant* for the Section of Rural Economy of the Paris Academy of Sciences, at Paris on January 22, aged eighty.

Prof. S. E. Whitnall, formerly Robert Reford professor of anatomy in McGill University and later professor of anatomy in the University of Bristol, on February 19, aged seventy-three.

NEWS and VIEWS

Directorship of the British Museum (Natural History): Mr. N. B. Kinnear, C.B.

Norman Boyd Kinnear, who retires from the post of director of the British Museum (Natural History) on April 30, will then have completed forty-five years of service to museums in Great Britain and India. Before he joined the staff of the British Museum in 1920, he had been twelve years curator of the Bombay Natural History Society's museum (1907–19), and for two years previous to that a voluntary assistant at the Royal Scottish Museum in his native city of Edinburgh. His work as an ornithologist is well known (see *Nature*, 160, 252; 1947). He worked in the Bird Room of the British Museum for twenty-five years, first as an assistant keeper and, from 1927, as deputy keeper. He was appointed keeper of zoology in 1945, and in 1947, although then at the normal retiring age, he was appointed director for a period of two years in succession to the late Sir Clive Forster-Cooper. At this time repairs to the war-damaged parts of the buildings at South Kensington were well advanced and re-decoration of some of the galleries was in progress; in 1948 almost every month saw some new section of the Museum opened to the public. Kinnear secured additions to the special exhibition staff set up by Forster-Cooper and encouraged a high standard in new exhibits in every department. Improved facilities for museum lectures were provided, and a Children's Centre and Junior Naturalists' Club were started and were very successful.

The most difficult problem Mr. Kinnear had to face in 1947 was that of finding room for the great collections which had to be removed from war-damaged galleries and stored in other parts of the building. In his brief term of office, Mr. Kinnear has gone a long way towards solving this major problem. It is owing to his efforts that there is now hope of the provision in the near future of sufficient accommodation to enable the collections to be re-housed and to make them more available for scientific research than they have been since the type specimens were sent out of London in 1939. Mr. Kinnear has taken an active interest in the work of all departments and in the welfare of his staff. Outside the Museum he has served on many committees concerned with the work of museums, with the promotion of Nature reserves and of field studies. He is a vice-president of the Zoological Society and chairman of the British Section of the International Committee for Bird Preservation.

Prof. G. R. de Beer, F.R.S.

The announcement that Prof. Gavin R. de Beer, professor of embryology at University College, University of London, has been appointed director to succeed Mr. Kinnear has given widespread satisfaction in zoological circles and in the scientific world in general. He was educated at the École Pascal in Paris, Harrow School and Magdalen College, Oxford, where he was a Demy. He graduated in 1921 with first-class honours and was awarded the Christopher Welch Research Scholarship, was Rolleston prizeman in 1922 and a year later won a prize fellowship at Merton College which he held until he left Oxford in 1938. During this period he was also Jenkinson Memorial lecturer, and latterly reader, in embryology. In 1938 he became head of the Department of Embryology at University College, London, first as reader and then professor. He was awarded his D.Sc. in 1932 and elected a fellow of the Royal Society in 1940.

His wide range of zoological interest is shown by the subjects dealt with in his many books and papers. Apart from those which perhaps we may call his major works, "The Development of the Vertebrate Skull", "Vertebrate Zoology" and "The Comparative Anatomy, Histology and Development of the Pituitary Body", he has written books on growth, genetics, experimental embryology and an especially important study of the contributions that embryology has to make to the theory of evolution. There has been a growing feeling among zoologists that the research workers in our museums should be given more opportunity, if they wish it, for study in the field so as to bring to their taxonomic work more of the evolutionary spirit which gives life and significance to what we now usually speak of as the 'new systematics'. While the new Director can scarcely be regarded as primarily a field naturalist, his width of outlook gives us an assurance that he will be sympathetic to the need for contact with life in the field ; we see him seeking refreshment in his "Escape to Switzerland" and "Alps and Men". He is also editor of *Notes and Records of the Royal Society*. In 1946 he was elected president of the Linnean Society, an office he held until 1949.

Engineering at Manchester : Prof. J. L. Matheson

PROF. J. L. MATHESON, of the University of Melbourne, has been appointed Beyer professor of engineering and director of the Whitworth Laboratories in the University of Manchester, and hopes to be able to take up the appointment at the beginning of the next session. Prof. Matheson is an old student of Manchester, having graduated there in 1932. After a period of research leading to the degree of M.Sc., he spent some years obtaining practical training, after which he became a lecturer in the Civil Engineering Department of the University of Birmingham. From there he was appointed three years ago to the chair of civil engineering at Melbourne. While in Australia, Prof. Matheson has taken an active part in extra-mural activities. He is a member of the Hydro-Electric Commission for New South Wales and chairman of the Committee on Building Research. The appointment of Prof. W. R. Hawthorne to the Manchester chair (see *Nature*, March 5, 1949, p. 355) was cancelled owing to the inability of Prof. Hawthorne to accept the post.

Directorship of Aslib : Miss E. M. R. Ditmas

MISS E. M. R. DITMAS retired on February 28 from her position as principal officer of Aslib (formerly the Association of Special Libraries and Information Bureaux, with which is incorporated the British Society of International Bibliography). She had occupied this post since June 1933, first as secretary and then, since 1946, as director. Aslib loses an officer of wide experience whose work had gained the respect, as she herself had won the affection, of those who worked with her. In her early years, Miss Ditmas was best known to the general body of members at the annual conferences, to the success of which her enthusiasm, organising ability and pleasant personality contributed so much. She was always particularly interested in the technical side of Aslib's work, and was fully alive to the potentialities of such new developments as microfilming. When the outbreak of war in 1939 interrupted much of Aslib's normal activities, she played a large part in the development of services to meet the new conditions, such as the Microfilm Service and the Location Indexes for Periodicals. Much of the responsibility for representing Aslib on other bodies fell to Miss Ditmas ; but her services in this capacity on such bodies as the Council of the National Book League, the British National Committee of Documentation, and, latterly, on the Library Committee of the British National Committee of Unesco, and at conferences of the International Federation of Documentation, brought her into touch with wider circles, where her enthusiasm and scholarship assisted the appreciation of Aslib's work. In post-war years the movement which led to the formation, first, of a Northern, and, more recently, of a Scottish Branch of Aslib, also owed much to her sympathy and co-operation. With the growth of Aslib, administrative responsibilities have demanded an excessive proportion of her time ; her scholarly interests, so well displayed in some of her papers—notably those on special libraries given at the Royal Society's Empire Scientific Conference in 1946, on the "Co-ordination of Abstracting Services" and other papers in the *Journal of Documentation*—have suffered, and she is now devoting more time to such study and research.

Mr. Leslie Wilson

MISS DITMAS is succeeded by Mr. Leslie Wilson, a former scholar of Trinity Hall, Cambridge, and foreign editor of *The Times Educational Supplement*. After graduating from Cambridge, Mr. Wilson served for six years at home, in India and Ceylon as a Staff Officer, first in the R.A.P.C. and then in the R.A.E.C. Three and a half years with *The Times Educational Supplement* brought him many personal friendships with teachers and educational officials in all parts of the world, and he has numerous contacts with industry, the professions and learned societies in Great Britain which should stand him in good stead in his new duties. Unesco has always been the object of his enthusiastic, if often critical, interest, and his dispatches on the first Paris conference in 1946 probably did more than any other source to make Unesco's aspirations known in Britain. A fluent linguist, he is a member of Council of the Modern Language Association and editor of its journal, *Modern Languages*.

Royal Society of Edinburgh : New Fellows

THE following were elected fellows of the Royal Society of Edinburgh at the ordinary meeting held on March 6 : Mr. D. Band, lecturer in urological surgery, University of Edinburgh ; Prof. R. M. Barrer, professor of chemistry, University of Aberdeen ; Sir Alexander Biggam, director of the Edinburgh Post-Graduate Board for Medicine ; Dr. C. H. Cadman, plant pathologist, University College, Dundee ; Dr. N. Campbell, lecturer, Department of

Chemistry, University of Edinburgh; Prof. J. K. Charlesworth, professor of geology, Queen's University, Belfast; Prof. E. G. Cullwick, Watson-Watt professor of electrical engineering, University of St. Andrews; Prof. D. H. Everett, professor of chemistry, University College, Dundee; Mr. E. Ford, director of the Marine Biological Station, Millport; Mr. G. F. Friend, lecturer in zoology, University of Edinburgh; Dr. A. R. Gemmell, Department of Botany, University of Manchester; Mr. A. S. Gillespie, Biological Department, Loretto School, Musselburgh; Dr. J. Iball, lecturer in physics, University College, Dundee; Dr. B. C. King, lecturer in geology, University of Glasgow; Mr. J. Knox, principal geologist, H.M. Geological Survey (Scottish Branch); Dr. A. Lamont, geologist; Dr. R. C. Menzies, research chemist, Department of Chemistry, University of Edinburgh; Dr. A. Milne, principal scientific officer, Agricultural Research Unit of Insect Physiology, King's College, Newcastle upon Tyne; Prof. G. L. Montgomery, St. Mungo-Notman professor of pathology, University of Glasgow; Mr. D. E. J. Offord, superintendent, Naval Construction Research Establishment, Rosyth, Fife; Lord Patrick; Mr. G. A. Scott, head of the Natural Science Department, George Heriot's School, Edinburgh; Dr. C. A. Stewart, senior lecturer in pure mathematics, University of Sheffield; Mr. J. A. Thomson; and Prof. V. C. Wynne-Edwards, regius professor of natural history, University of Aberdeen.

University College, Makerere, East Africa

The Secretary of State for the Colonies, Mr. James Griffiths, has announced that Makerere College in East Africa has been admitted to special relationship with the University of London, and that the Inter-University Council for Higher Education in the Colonies has agreed to recognize it as having attained the status of a university college. Students at the College will now be able to read for the degrees in arts and science of the University of London. The College, situated a few miles outside Kampala in Uganda, is an autonomous institution, supported by the Governments of Kenya, Uganda, Tanganyika and Zanzibar. The Secretary of State for the Colonies, on the advice of the Colonial University Grants Advisory Committee, has agreed to make grants totalling £1,100,000 under the Colonial Development and Welfare Act available to the College, chiefly for capital developments.

The Secretary of State also announces the appointment of Prof. Bernard de Bunsen to be principal of the College. Prof. de Bunsen was born in 1907. He was educated at Leighton Park School and Balliol College, Oxford. After wide experience in educational work in schools and administration, he joined the Ministry of Education as an inspector; he was seconded from the Ministry in 1946 to serve as director of education in Palestine. He left Palestine on the withdrawal of the British Administration and was appointed professor of education at Makerere College in May 1948. In August last year he became vice-principal of the College and also acting principal. He has travelled extensively in Europe and Africa and has a wide knowledge of foreign educational systems and methods.

Centenary Anniversary in the British Optical Industry

William Wray, a nineteenth-century solicitor, of Highgate, was a keen amateur astronomer and built his own telescope. Having successfully made a number of object glasses for his friends, in 1850 he converted his coach house into a workshop and set up in business as a telescope maker. Wray telescopes soon became well known and were sold all over the world; and in photography, the 'Platystigmat' was one of the first lenses with anastigmatic flattening of the field to be produced in Great Britain. In 1908 the firm was made into a limited company and came under the direction of Mr. A. A. Smith, who introduced the manufacture of prismatic binoculars. These, together with photographic lenses for aerial survey, were made in such large quantities during the First World War that the premises had to be removed to a larger site at Bromley, Kent, where they are to be found to-day. In spite of set-backs immediately after 1918, and again in 1930–31, the firm steadily increased in size in the period between the two World Wars. During 1939–45 all sorts of optical instruments were produced, one outstanding achievement being the re-designing of a 36-in. telephoto lens used for reconnaissance, which resulted in an improvement in resolution in the margin by a third. Among the things of note since 1945 may be mentioned the Wray 2-in. *F*1 anastigmat, specially designed for the photographing of transients from cathode ray tubes on to 35-mm. film, and a recent wide-angle anastigmat with focal length of 89 mm.; the latter adequately covers a half-plate, representing 100° when stopped down at *F*16, and focusing can be done at *F*6·3. As its contribution to Britain's dollar drive, Wray Ltd. exports fifteen per cent of its total output to American countries. With the present happy relationship prevailing among its workers, the firm can look back with pride on its hundred years of progress in the British optical industry.

Council for the Promotion of Field Studies

The report for 1948–49 of the Council for the Promotion of Field Studies shows that the four field centres at Malham Tarn, Flatford Mill, Juniper Hall and Dale Fort are now open all the year round except for short breaks in the winter. The great variety of students who have already made use of the centres include a large number of groups from university departments; this demand is likely to grow as the opportunities for field work at the centres become more widely known. The University of London in particular has made great use of the centres, and students have been sent from nearly every one of the constituent colleges. For the third time practical courses for the certificate of proficiency in natural history have been held at Flatford Mill Field Centre in association with the Extra-Mural Department of the University of London. The proportion of teachers who attend courses is steadily growing; but although a number of sixth-form grammar school students have been able to make use of the centres, many have been prevented from doing so by the difficulty of obtaining grants-in-aid from their local education authorities.

Effect of Potato Virus X on Yield

Potato virus X is economically important in the virus situation mainly because it forms a constituent of more severe disease complexes. It can, nevertheless, cause some direct reduction in yield, which has been measured by Phyllis E. M. Clinch and Robert McKay (*Sci. Proc. Roy. Dublin Soc.*, **25** (N.S.), No. 8; July 1949). They used two clones of the variety 'Up-to-Date'; one of them was reduced in yield by about ten per cent by two strains of the virus. The other clone was not reduced in yield by either strain. These results agree with earlier studies by the same workers. It is also concluded that the reaction of the virus upon a particular clone may be considerably affected by environmental conditions.

Industrial Research and Management

A REPORT of the conference of industrial research directors and managers held at Ashorne Hill, Leamington Spa, during March 11–14 (see *Nature*, 163, 828; 1949), has now been published (pp. 123; London: Federation of British Industries, 1949; 2*s*. 6*d*.). It includes the papers presented in full, with summaries of the contributions to the discussion. A list of delegates and a list of publications of the Industrial Research Committee of the Federation of British Industries are appended.

Discussion on Heterogeneous Catalysis

THE Faraday Society is organising a general discussion on heterogeneous catalysis, to be held at the New Arts Theatre, University of Liverpool, during April 12–14, with Sir John Lennard-Jones in the chair. As a general introduction, Prof. H. S. Taylor, professor of physical chemistry in Princeton University, will deliver the Spiers Memorial Lecture (the first since the Second World War), his subject being "Surface Catalysis: Retrospect and Prospect"; this Lecture was founded in memory of Mr. F. S. Spiers, one of the founders, and secretary during 1903–26 of the Society. Forty-two papers have been prepared for the discussion, in the following four sections: (1) theories of adsorption and properties of surface layers; (2) adsorption and catalysis on metals; (3) adsorption and catalysis on oxides; (4) techniques. It is hoped to circulate advance proofs of the papers by March 29, and at the discussion authors will only be allowed to speak for five minutes on salient points. Further particulars can be obtained from the Secretary, Faraday Society, 6 Gray's Inn Square, Gray's Inn, London, W.C.1.

Conference of the Stress Analysis Group of the Institute of Physics

THE Stress Analysis Group of the Institute of Physics will be holding its fourth annual conference during April 3–5 at University College, London. The conference will begin at 3.30 p.m. on April 3 with a session on brittle lacquers. The morning session of April 4 will be devoted to papers and discussions on the use of models in structural work, including structural engineering, shipbuilding and aircraft construction. In the afternoon the topic will be on recent developments in photo-elasticity. The morning and afternoon sessions of April 5 will be devoted to papers and discussions on the application of experimental stress-analysis methods to soil mechanics problems, and on experimental stress-analysis methods in the motor industry, respectively. The conference will be open to the public. Further particulars can be obtained from the honorary secretary of the Stress Analysis Group, Mr. E. K. Frankl, Engineering Laboratory, Cambridge.

Fellowships for Cancer Research

THE British Empire Cancer Campaign is inviting applications for fellowships in cancer research. Senior fellowships will normally be tenable for seven years at a salary of £2,000 rising by £100 increments to £2,600 per annum; junior fellowships will be tenable for three years at a salary of £1,000 rising by £100 increments to £1,200 per annum. Fellowships are open to graduates of British nationality with no restrictions as to age, although the election of a junior fellow above the age of thirty-five is unlikely. The first elections will take place in June this year, and work, if possible, will begin on October 1. Fellows must carry on their research initially in Great Britain or in Northern Ireland, and only at the place at which they are authorized by the Campaign to work. The fares of successful candidates from overseas will be paid by the Campaign. Further particulars and application forms, to be returned by May 1, can be obtained from the General Secretary, 11 Grosvenor Crescent, Hyde Park Corner, London, S.W.1.

Cecil Peace Prize

THE 1949 award of the Cecil Peace Prize has been divided between Mr. M. Foss, of Jesus College, Cambridge, and Mr. P. J. Gilder, of King's College, Cambridge. The subject of the essay was "What international action should be taken with regard to the many millions of displaced or expelled persons and refugees in Western Europe, with a view to both the restoration of European economy and to the utilisation of labour power now running to waste". The Prize is an annual award, worth £100, and is open to all members (less than twenty-five years old) of the universities of the United Kingdom. The subject for 1950 is: "What is meant by the Balance of Power? And has its attempted maintenance since 1660 been useful for Peace or not?" Essays must be sent in before November 1 to the Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1.

Announcements

GUSTAVO COLONNETTI has been elected *correspondant* for the Mechanics Section of the Paris Academy of Sciences in place of M. Maurice Roy, who has been elected a member of the Section. Hans A. Pallmann has been elected *correspondant* for the Section of Rural Economy in place of the late M. André Boivin.

MR. F. P. SLATER, of Fine Spinners and Doublers, Ltd., Rock Bank, Bollington, near Macclesfield, has been elected an honorary life member of the Textile Institute, in recognition of his services to the Institute.

THE Chemical Society invites applications for grants for research in all branches of chemistry. Such applications must be submitted on the appropriate form, not later than May 1, to the General Secretary, Chemical Society, Burlington House, Piccadilly, London, W.1, from whom further particulars can be obtained.

AN international symposium on ultrasonics, organised by the Italian National Research Council and the Italian Physical Society with the collaboration of the International Union of Physics, will be held in Rome during June 14–17. Arrangements for the symposium are being made by Prof. Amadeo Giacomini, professor of physics, University of Trieste.

A LIST of papers, corrected to January 21, has recently been published in connexion with the Fourth World Power Conference, to be held in London during July 10–15 (see *Nature*, December 17, 1949, p. 1035). Applications for membership can still be accepted, the forms being obtainable from the Offices of the Fourth World Power Conference, 414 Cecil Chambers, 76 Strand, London, W.C.2.

MICRORADIOGRAPHIC DEMONSTRATION OF TISSUES TREATED BY METALLIC IMPREGNATION

By Prof. G. A. G. MITCHELL
Department of Anatomy, University of Manchester

VARIOUS earlier attempts to obtain minute radiographic detail culminated in the remarkable results reported by Lamarque (1938)[1]. He used very soft X-rays (2–12 A.) and films coated with extremely fine emulsions of the Lippmann type invented for interferential photography. His equipment was elaborate, consisting of a special generator, a camera sealed to a diffraction X-ray tube so that both could be evacuated to a high vacuum, a lithium window and an ingenious plate changer.

By means of his apparatus Lamarque obtained what he termed microradiographs, and owing to the extremely fine grain of his films he could examine them microscopically and obtain magnifications up to 250 or more by microphotography.

Doubtless owing to the complicated nature of his equipment, apparently the only serious attempts to follow Lamarque's lead were made by Bohatyrtschuk (1944)[2] and Barclay (1947)[3]. The latter evolved a simpler technique involving the use of a modified two-valve generator, a standard diffraction tube, and maximum resolution plates; and while he failed to obtain detail comparable to Lamarque's best, nevertheless his methods provided excellent results. He obtained a × 50 enlargement from his microradiographs by microphotography, and then printed off enlargements from the microphotographic negatives. He used his method mainly to study the arrangement of vessels injected with radio-opaque solutions, but in one case (Barclay, 1949)[4] he demonstrated iron in a lung almost as clearly as Lamarque *et al.* (1936)[5] had shown bismuth salts in the spleen.

One had the idea that Barclay's methods might be employed to study the arrangement of various tissues having a selective affinity for silver salts. In particular, it was hoped to obtain a clearer picture of intrinsic glandular innervation, a subject still shrouded in considerable obscurity; but the existing metallic techniques are notoriously capricious when applied to such viscera, and no good pictures have yet been obtained of the ramifications of nerves within glands. It is possible, however, to demonstrate larger nerves (Fig. 1) and nerve bundles (Fig. 2) in sections stained by Cajal's, Bodian's, Romanes's and Wrete's techniques, and probably much finer filaments could be demonstrated by using the Lamarque type of equipment.

Reticular tissue also has argyrophil properties and can be revealed by microradiography after appropriate staining, for example, by Gomori's or Lillie's techniques. In the microradiograph reproduced (Fig. 3), the reticulum may appear unduly conspicuous to those accustomed to looking at ordinary histological slides; but the picture was obtained from an 80-μ section.

It is usually believed that nerve and reticular fibres have a greater affinity for silver than most other tissues; but microradiography raises doubts about this. Certainly muscle and collagenous fibres show up well in microradiographs of sections stained by silver techniques (Fig. 4). Indeed, the collagenous bundles constituting tendons cast denser shadows than nerves of approximately equal size. It is therefore possible that the relative histological prominence of nervous and reticular tissue in silver-impregnated sections is due, not to their selective affinity for the metal, but to some physico-chemical interaction with it which does not occur to the same extent with other fibres, and which renders them darker in colour when viewed through the microscope. Some claim that reticular fibres are immature collagen and that in silver-stained microscopic sections direct continuity between the darker reticular and paler collagenous fibres may sometimes be traced. In

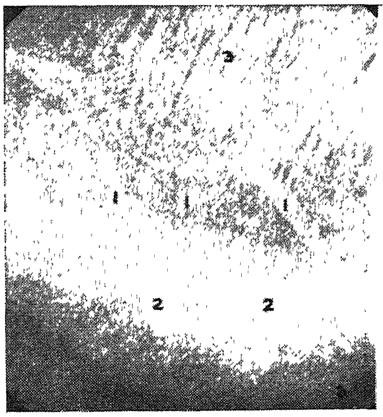

Fig. 1

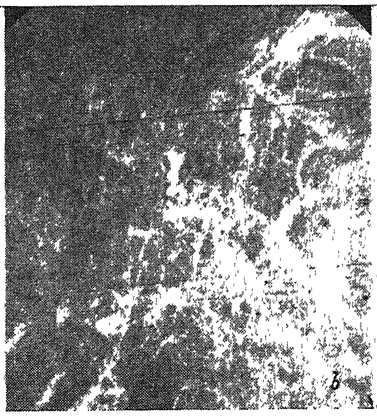

Fig. 2

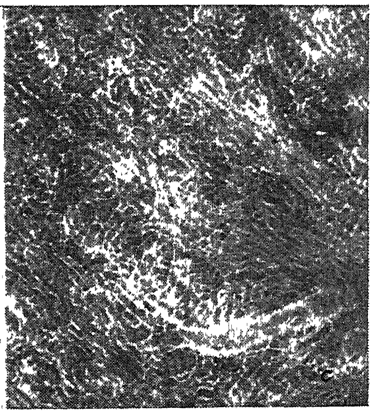

Fig. 3

Fig. 1. Microradiograph (× 73) of region of metacarpal head in human fœtus impregnated by Wrete's method. 1, Nerves. 2, Vessels. 3, Collagenous fibres. The metacarpal head is outside the field reproduced

Fig. 2. Microradiograph (× 80) of delicate retroperitoneal plexus adjacent to intermesenteric nerves (pre-aortic plexus) stained by Bodian's method. Most of the filaments visible are delicate nerves, but some are collagenous fibres

Fig. 3. Microradiograph (× 34) of reticular network in monkey's kidney stained by Gomori's method

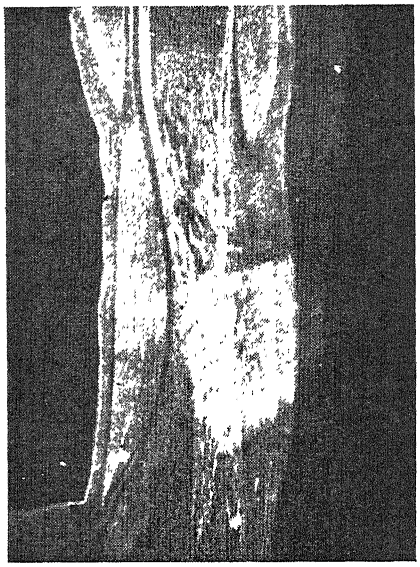

Fig. 4. Microradiograph (× 12) of human fœtal arm impregnated by Wrete's technique. Certain bony and muscular details are apparent and the tendons (which are largely collagenous) are clearly visible, for example, the tendons of biceps brachii

microradiographs colour variations are absent and they reveal that, despite the histological evidence which apparently shows that collagenous are much less argyrophil than reticular fibres, in fact both attract silver almost equally. This is exemplified in structures such as the spleen, the lymph nodes and the kidney, where the capsules, which are mainly collagenous, show up as clearly in microradiographs as the reticular tissue within them.

Thick sections (40–400 μ) have to be employed in microradiography by Barclay's technique for two main reasons: (1) thin sections do not contain enough metal to cast good shadows unless one is fortunate enough to possess the Lamarque type of equipment; and (2) the exposures vary between two and fifty minutes, and during this time it is difficult to avoid drying and crinkling of thin sections, with consequent blurring of the picture. The air cannot be humidified because this would hinder the passage of soft X-rays, and any moisture on the photographic plates increases the length of exposure required.

Thicker sections have some positive advantages. They enable the investigator to trace the arrangement of fibres over greater distances than is possible in ordinary histological sections (average thickness 5–10 μ), and if combined with stereoscopic methods of microradiography they may provide a possible alternative to the drudgery of serial sections and wax reconstructions for certain purposes, for example, studies of the distribution of nerves or of ossification. Bony structures have the advantage that they are naturally radio-opaque.

The lack of sharp definition in microradiographs is due to a combination of causes: X-ray scatter; the thickness of the sections used; the fact that some deposition of silver occurs throughout the entire section; and at higher magnifications the granules, even in fine photographic emulsions, become apparent.

In conclusion, it must be emphasized that microradiographs are merely shadows, revealing in a relatively easy way the pattern in which certain tissues are arranged. They are an adjunct to, and not a substitute for, ordinary histological methods.

I am indebted to Prof. M. Wrete of Uppsala, who kindly gave me a fœtal limb impregnated by his method[6]. My thanks are also due to Messrs. F. L. Newell, H. Gooding, K. Pearson and P. Howarth for radiographic, photographic and histological help. The cost of the investigation was partly defrayed with the aid of a technical expenses grant from the Medical Research Council.

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MUSCLE PROTEINS AND THEIR INTERACTION WITH ADENOSINE TRIPHOSPHATE

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In recent years, such conflicting statements of the action of adenosine triphosphate on actomyosin have appeared[1,2,3], that it has appeared impossible to decide on the actual mechanism involved. During the course of an investigation of the muscle proteins by ultracentrifuge and light-scattering methods, some clear-cut results have emerged and these are outlined below. A more detailed report will be presented elsewhere later.

It is necessary first to review briefly the nature of the various muscle fractions, prepared from rabbit muscle by the methods of Szent-Györgyi and his school, as shown by ultracentrifuge examinations. Least complicated, it would appear, is the so-called crystalline myosin, which, on the basis of several preparations, sediments as a single (perhaps composite) peak over a range of protein concentrations up to 0·8 gm./100 c.c., and between 0·3 *M* and 0·6 *M* potassium chloride. Sedimentation is apparently unaltered by the presence of 0·1 *M* magnesium chloride with 0·3 *M* potassium chloride. Fig. 1*a*, showing the sedimentation of myosin in 0·55 *M* potassium chloride at a protein concentration of 0·2 gm./100 c.c., is very reminiscent of the sedimentation of linear polymers[4,5], and it should be noted that in such cases the absence of peak-spreading during sedimentation cannot be assumed a proof of monodispersity, since concentration effects cause an artificial sharpening of the boundary. Even so, however, a considerable asymmetry of the boundary is sometimes observed, and at low protein concentrations (less than 0·2 gm./100 c.c.) normal boundary-spreading occurs (Fig. 1*b*). The sedimentation constant in 0·5 *M* potassium chloride, extrapolated to infinite dilution and corrected to the viscosity and density of water (s^0_{20}), is 7·2 S., in agreement with the published value of Snellmann and Erdos[6]. Below 0·3 *M* potassium chloride, aggregation of myosin appears to occur, resulting in a polydisperse and a 'multi-peak' sedimentation diagram.

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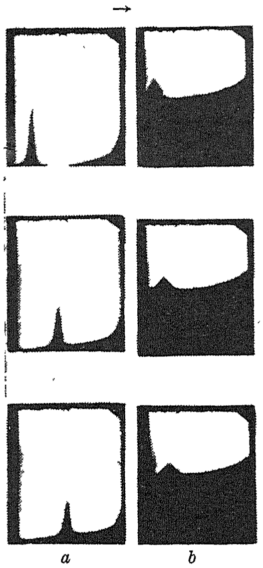

Fig. 1

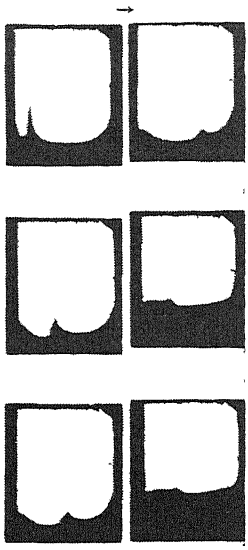

Fig. 2

Fig. 1. Sedimentation diagrams of myosin in potassium chloride solution
(a) Protein concentration = 0·2 gm./100 c.c.; KCl = 0·55 M; pH = 8·0
(b) Protein concentration = 0·045 gm./100 c.c.; KCl = 0·50 M; pH = 7·4

Fig. 2. Sedimentation diagrams of water-extracted actin in 0·05 M KCl, pH = 7·1

The addition of 0·0016 M adenosine triphosphate to myosin solutions caused no change in the sedimentation diagrams, in the observed sedimentation constant, or in the solution viscosity.

In contrast to myosin, actin appears from the ultracentrifuge to be a very ill-defined and somewhat variable material (Fig. 2). In order to remove charge effects in the sedimentation of charged colloids, it is necessary to work in the presence of appreciable salt concentrations. Accordingly, it is not possible to study G-actin under the conditions postulated by Szent-Györgyi. In 0·05 M potassium chloride, over a protein concentration-range of 0·2–0·3 gm./100 c.c., the sedimentation diagrams of actin usually show two main components: a fast, sharp peak with a sedimentation constant *c.* 50 S. and a slow, asymmetric and rapidly spreading peak with a range of sedimentation constants from 4·5 to 6·0 S. The addition of 0·002 M adenosine triphosphate to an actin solution in 0·5 M potassium chloride gave no significant change in relative viscosity.

Actomyosin, while somewhat variable from preparation to preparation, is much better defined than actin. In Weber solution (0·6 M potassium chloride; 0·04 M sodium bicarbonate; 0·01 M sodium carbonate) actomyosin sediments as two main components (Fig. 3), one of which, the slower one, somewhat variable in quantity, is usually indistinguishable in sedimentation from myosin. This was shown by addition of a myosin solution to that of actomyosin, when the only observable result was an increase in the slow actomyosin peak. In other cases, however, the slow actomyosin peak was less well defined, showing greater spreading than expected of myosin and more reminiscent in this and its sedimentation-rate of actin. The rapid peak of actomyosin showed large concentration effects, possessing an s^0_{20} value in excess of 60, while at a concentration of 0·13 gm./100 c.c. the sedimentation constant was 15 S. As a result of such concentration effects, except at very low concentration (less than 0·10 gm./100 c.c.) this rapid peak was extremely sharp and easily visible. Changes in it, with which we are concerned below, were therefore readily observed (Fig. 3).

Myosin and actin solutions in 0·5 M potassium chloride, when mixed over a range of relative and absolute concentrations, showed large increases in viscosity and indications of gel structure. Thus, on adding 8 volumes of a 0·2 gm./100 c.c. myosin solution of relative viscosity 1·46 to two volumes of an F-actin solution of relative viscosity 2·175, the observed relative viscosity was 1·89, while on adding 0·2 volumes of 0·1 M adenosine triphosphate solution to the mixture, it became 1·495. Assuming simple additivity of the viscosities of the two components, the calculated relative viscosity of the mixture is 1·60, which is significantly higher than the observed value for the mixture after addition of adenosine triphosphate. On Szent-Györgyi's views, this is explained by the regeneration of the actin from the actomyosin complex in the G- rather than the F-form in which it largely occurred initially.

Such mixtures were also examined in the ultracentrifuge, and in addition to a complex gel-like component which sedimented rapidly and completely at 60,000 g, it was confirmed that the usual actomyosin sedimentation diagram with a rapid, sharp peak and a slower component was observed. It is probable that the gel-like component arises as a result of the higher actomyosin concentration in

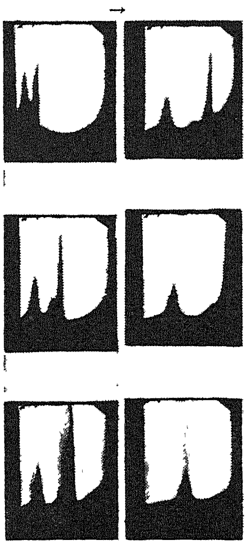

Fig. 3

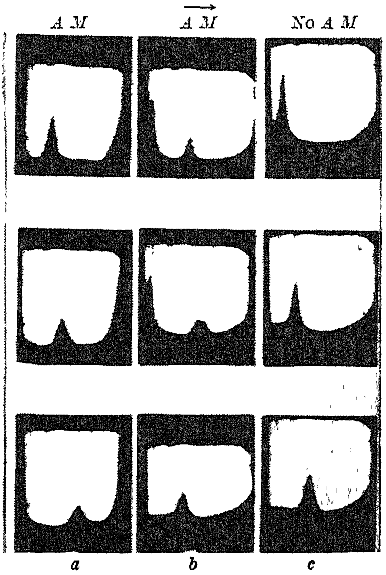

Fig. 4

Fig. 3. Typical sedimentation diagrams of natural actomyosin in Weber solution. Protein concentration = 0·35 gm./100 c.c.; pH = 8·4

Fig. 4. Action of adenosine triphosphate on natural actomyosin. Sedimentation diagrams in Weber solution of:
(a) Natural actomyosin. Protein conc. = 0·25 gm./100 c.c.
(b) „ „ + 0·002 M adenosine triphosphate
(c) „ „ + 0·009 M „ „

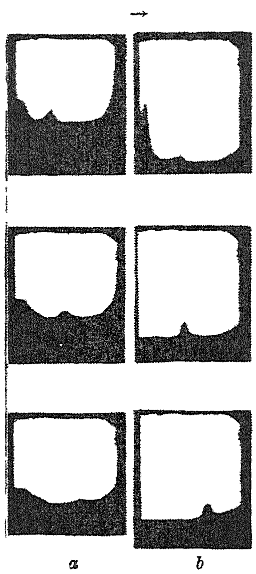

Fig. 5

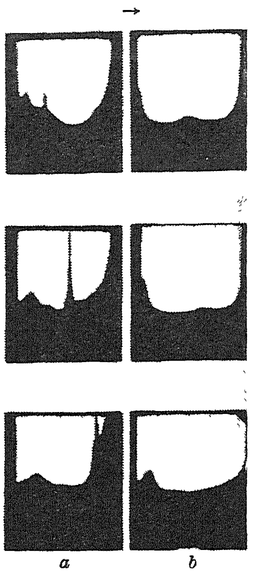

Fig. 6

Fig. 5. Action of adenosine triphosphate on synthetic actomyosin in solution containing 0·5 *M* KCl and 0·0003 *M* MgCl$_2$
(*a*) Synthetic actomyosin. Protein conc. = 0·25 gm./100 c.c.
(*b*) ,, ,, + 0·012 *M* adenosine triphosphate

Fig. 6. 'Dissociation' of actomyosin. Sedimentation diagrams in Weber solution of:

(*a*) Natural actomyosin. Protein conc. = 0·30 gm./100 c.c.
(*b*) Solution of rapidly sedimenting component of (*a*). Protein conc. *c.* 0·2 gm./100 c.c.

mixed myosin–actin solutions than can be obtained by actomyosin extraction by buffer solutions.

By changing the relative concentrations of the two components from high myosin to high actin, it was observed also that the character of the slow peak could be changed from the myosin-like type to the actin-like type. Thus the different sedimentation diagrams of natural actomyosin could be reproduced from appropriate actin–myosin mixtures.

The action of adenosine triphosphate on both natural and synthetic actomyosin provides a further indication of their similarity. In a natural actomyosin solution at a protein concentration of 0·25 gm./100 c.c., 0·002 *M* adenosine triphosphate caused a very appreciable fall in the rapid actomyosin peak, and at 0·009 *M* adenosine triphosphate the actomyosin peak had disappeared (Fig. 4). Similarly, in a synthetic actomyosin solution containing 0·17 and 0·08 gm./100 c.c. of myosin and actin respectively, the gel-like and actomyosin rapid components which occurred in the absence of adenosine triphosphate both disappeared in favour of a much larger concentration of the slowly sedimenting actomyosin component (Fig. 5). It would appear, therefore, that in sedimentation behaviour and reactivity to adenosine triphosphate, natural and synthetic actomyosin do not differ. Nor is it possible to explain the disappearances of the fast actomyosin component on the basis of a coiling of the actomyosin chains. Such coiling would only give a component of altered sedimentation constant, but would not cause its disappearance. The increased concentration of the slow actomyosin components can only mean dissociation of the complex into either its constituents or into components of similar sedimentation properties.

Having demonstrated that the actomyosin complex (*AM*) can be formed from actin (*A*) and myosin (*M*), it is of interest to inquire whether such complex formation is reversible, that is,

$$A + M \rightleftarrows AM.$$

No definite answer can yet be given, but certain indications may be mentioned. It has already been stated that the slow component in different actomyosin preparations varies from a sharp myosin-like to a rapidly spreading actin-like material. No actomyosin preparation containing only the rapidly sedimenting component has yet been made. Since each preparation involves several precipitations, it is surprising that a better separation from other components of quite different solubility was not obtained —unless such components are produced by complex dissociation. Further evidence has been provided in an attempt to separate the rapidly and slowly sedimenting actomyosin components by ultracentrifugation in a quantity rotor. Centrifugation at 140,000 *g* for one hour was sufficient, according to the results of analytical sedimentation experiments, to cause the complete sedimentation of the rapid actomyosin component, and after this treatment the supernatant liquid could be poured cleanly away from the firm gel-like sediment. The sediment was stirred and extracted with the original volume of Weber solution for 19 hr. With the original actomyosin solution, this solution was examined in the ultracentrifuge. Typical sedimentation diagrams for both solutions, shown in Fig. 6, show the surprisingly high relative concentration of the slow actomyosin component in the dissolved sediment. Assuming equal refractive index increments for the two components, the ratio $\frac{[\text{fast}]}{[\text{slow}]}$ has the values 1·1 and 1·0 for the original solution and extracted sediment respectively. It is further to be observed that the slow component in Fig. 6*b* has now much more of the character of myosin, which in the concentration observed could only appear from the dissociation of the sedimented actomyosin complex. These results have been repeated and confirmed.

The complex composition of some of the muscle protein solutions indicates the dangers of interpreting alone the results of colligative or similar methods. However, possessing results from sedimentation velocity analysis, such results may be interpreted with more confidence. In particular, a comprehensive light-scattering investigation of the muscle proteins has been carried out, and, although complete results are not yet available, it would appear that they are in general agreement with the ultracentrifuge work outlined above.

We acknowledge with pleasure our debt to Prof. E. K. Rideal for his interest in the work. To Dr. D. F. Cheesman and the Physiology Department of Bedford College, University of London, we are grateful for laboratory facilities, and one of us (R. L.) is indebted to Schweizerische Stiftung für Stipendien auf dem Gebiete der Chemie for a scholarship during the tenure of which this work was performed.

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RECENT BREEDING PHENOMENA IN THE AMERICAN SLIPPER-LIMPET, *CREPIDULA FORNICATA*

By Prof. J. H. ORTON, F.R.S.
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In the absence of intensive cultivation during the War, the American slipper-limpet, *Crepidula fornicata*, further established itself[1] as the dominant organism on the Essex oyster beds and thus attained the optimum state[2] for producing annual crops of young, namely, spatfalls. Nevertheless, in 1945 the spatfall was a virtual failure—resembling similar failures from time to time in the spatfall of the oyster—thereby providing a fact of considerable biological interest, since no failure has previously been recorded, although almost continuous observation has been kept on the species since 1910.

The virtual absence of the spatfall was observed during August 20–21, 1945, when the grounds of the Blackwater and Roach were thoroughly surveyed—by courtesy of Major A. Gardner—from a motor-boat towing four dredges.

On this date the slipper-limpets were found to be still breeding, covering capsules some of which contained recently spawned ova, some with veligers and some empty; thus larvæ were being produced at this time. There is evidence that planktonic conditions had been suitable for larvæ, as at the time of the survey there had been a moderately good fall of oyster spat in the Blackwater (5, 6 and 7 spat per shell being common, with a maximum on one shell of 32) though only a relatively poor fall in the Roach. In a season of good spatfall in the past, the young slipper-limpets would be at least as numerous as the oyster spat recorded in 1945 on the Blackwater and certainly far more numerous on the Roach; but in that year only occasional limpet spat were found. As a rough indication of frequency, thirty-four clumps (averaging seven to eight individuals) of slipper-limpets were taken at random and examined on the boat on August 21, 1945, for limpet spat; thirty-three of these clumps had no spat and only one had a 1945 spat, while only two chains had members 15–20 mm. long (1944 spat). In a comparable sample examined at Liverpool, taken on December 16, 1947, among eighty-one clumps (averaging about five individuals) fifty-eight had collectively 106 spat, twenty-three had none and eight spat were loose. Thus in this rough comparison, which has necessarily a limited value, limpet spat were at least fifty times more abundant in 1947 than in 1945. Estimations of spatfall in the future made on a more solid basis are desirable for following up this aspect of the biology of the slipper-limpet. The paucity of the spatfall in 1945 was checked and confirmed by the examination of four samples of about fifty clumps each, taken at the end of the season, in October 1945 and February 1946.

The rarity of young slipper-limpets in August 1945 had been noticed by the oyster dredgermen, who, along with Mr. E. Luckhurst, stated that spatfall had been poor or absent on some grounds also during some of the war years, but that oyster spatfalls had been good at times where there was no limpet spatfall. Mr. Luckhurst also states that there was a sprinkling of slipper-limpet spat in the Roach in 1946, but it did not live. It is therefore quite clear that after a successful and rampant invasion of the Essex oyster beds[3], *Crepidula* has recently suffered a check and is exhibiting some maladjustment with its new environment, and there is every reason to infer that the check is due to natural causes.

No satisfactory explanation can, however, be given for the failure of young limpets to settle in 1945, or during the war years. It was at first thought that the severe winters during the War—including 1945 when ice occurred on the oyster beds—may have affected the viability of the adults, particularly as after the extreme cold of February 1940 an *ad hoc* survey[4] showed that on the same grounds oysters were annihilated or succumbed in high proportions on some beds, and that slipper-limpets generally were weakened excessively and suffered some mortality. But the revival in spatfall of limpets in 1947, after the intensely cold period in February of that year when ice was generally prevalent in the Thames estuary, renders this explanation doubtful. Nothing is known of the parasites of *Crepidula* in British waters, so that this attractive problem remains to be investigated and may be related to the phenomena observed.

As slipper-limpets pair in the winter period, it seemed also probable that the reproductive products might be affected by long periods of low temperature especially if accompanied at times by low salinity. Little is known of the breeding habits of *Crepidula fornicata* in Great Britain apart from the hitherto unrecorded occurrence of a high proportion of copulating pairs in a sample of chains kept in dishes in the Plymouth Laboratory during the consecutive months of November, December 1911, and January and February 1912. The same pairs were seen in copula intermittently over a period of several days. Pairing can occur between couples in any position in a chain, for example, the second and third in a chain of five, or the fifth and ninth in a chain of eleven. It is significant that a small male individual was observed attempting to pair with a female four to five times its own size; thus it is possible that one-year old spat may function as males. Some of these pairings occurred after the dishes had been moved from a cold slab to the warmer bench, with a consequent rise in temperature of the water; their observation was, however, incidental to the work carried out at the time. It is an interesting fact that in a repetition of the observations in December 1912–January 1913, some individuals kept in the tanks had spawned on January 31, whereas none was found with spawn among a few large consignments received later direct from the Essex beds until March 7, when three individuals were covering spawn out of a sample of four to five hundred individuals (about two hundred females).

From field observations it is probable that pairing occurs generally in late autumn and early winter as well as at other times, the female storing the sperm in recepticula seminis until spawning begins during February–March. Intense cold with low salinity may affect spawning behaviour, though it is doubtful whether mere low temperatures would affect the viability of sperm. It is not improbable, on the other hand, that the effect of unfavourable conditions on the female might be reflected in the viability of the larva. In this respect there is reason to suspect that failure to obtain spatfalls of oyster larvæ in ponds, where the parent oysters used have been transported from some distance, may be due to the weakening effects of transport reflected in the reproductive products, and failure of the larvæ to settle. Definite evidence of the effect of extreme cold in preventing spawning of plaice in ponds in 1947 is given by Smith[5].

While normal crops of young marine animals are dependent upon a normal seasonal integration of life in the sea, each successive phase in the life-history being dependent upon normal environmental conditions, including the provision of appropriate food-organisms—and only normal prevalence of predators and parasites—the failure of crops may be due either to deviations from these conditions, or perhaps more usually merely to hydrographic accidents which prevent the larvæ from arriving over suitable ground for settlement at the right time[6]. Nevertheless, there is no reason to relate the failure of the spatfall of *Crepidula* in 1945 to hydrographic accidents, as their larvæ would co-exist mainly with those of the oyster which settled. Known absences of young of such forms as *Aplysia*, *Grantia*, *Archidoris* (at Plymouth) and even oysters (Essex estuaries) may be referred at times to the accident category. On the other hand, although years of unusual abundance (for example, oysters[7], *Mytilus*[6]) of species are generally bound up with problems of population, distribution, and appropriate general environmental and food conditions, as noted above, the less obvious factor of good physiological conditions of the adults, though important, can rarely be assessed and is generally presumed.

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INTERNATIONAL SECRETARIATS

FIVE years ago, the problems arising in the staffing and administration of an international secretariat were discussed in the light of experience gained with the League of Nations in two pamphlets issued by the Royal Institute of International Affairs (see *Nature*, **154**, 221, 1944; **157**, 308, 1946). Those problems as they affect the United Nations and some of the Specialized Agencies have been examined recently after the further experience of their first formative years by Political and Economic Planning, and two recent broadsheets (*Planning*, Nos. 298 and 307) attempt to indicate broadly some of the problems most urgently in need of solution and to describe in broad terms the way in which they have been tackled by the United Nations and its agencies. The first of these broadsheets surveys the staffing problems, while the second reviews the broad question of the functions of the secretariats and their relation to their respective policy-making bodies.

The creation of a balance between national and international loyalties was a problem which the League of Nations had to face early in its history, and the broadsheet quotes from Sir Arthur Salter, writing in 1930, on the necessity of some senior officers in an international secretariat possessing international loyalties which transcend the acceptance of instructions from their own national governments. Experience of the League of Nations and of the International Labour Organisation seems, in fact, to demonstrate that the concept of international loyalty is practicable. An administration drawn from nationals of many countries can be highly efficient, and a secretariat the members of which consistently display international loyalty will readily command the confidence of national delegations. Delegations will readily supply it with information, and its advice is more readily accepted when its impartiality is trusted.

Discussing the geographical distribution of the staff and the difficulty of ensuring a wide distribution and the highest standards of competence, integrity and efficiency, P E P believes that, on balance, in an international organisation mere efficiency cannot be, and perhaps should not be, the only aim. Provided there is enough flexibility to avoid unsuitable appointments to key positions, some concession to national feeling among member States may in the long run result in more gain than loss.

Discussing next the question of appointments, P E P suggests it may be too early to say what balance should be struck, as a long-term policy, between permanent and temporary staff. The recommendations of the Preparatory Commission of the United Nations gave insufficient weight to certain factors affecting especially the less-developed countries. Moreover, while it may be an advantage from some points of view to have easy and frequent interchange of national and international officials, the larger proportion of short-term staff does involve the danger that national Civil servants seconded for a short period only may retain their national feelings throughout their appointment and fail to assume an international loyalty. Nevertheless, *Planning* suggests that the problem is largely one of emphasis and timing, with the ideal proportions of permanent and short-term appointments varying from time to time according to the nature of the work to be done and the availability of suitable people.

As regards qualifications, P E P points out that until certain matters of basic policy, such as the nature of research work to be undertaken by a particular section and the nature and administrative responsibilities of the high posts in relation to the whole organisation, are settled, one of the most urgent tasks is a broad classification of posts into those normally filled by specialists, those normally filled by general administrators, and those in which there will always be some interchange. Moreover, the specialist character of the secretariat will largely determine the extent to which outside consultants are used, and here *Planning* suggests that fuller use might with advantage be made of "corresponding consultants". Commenting on the different recruiting methods adopted empirically by the United Nations and the Specialized Agencies, it suggests that, from the point of view of the applicant, a common recruiting agency for all the organisations would be of great advantage, but that it is doubtful whether such an agency is really feasible. Much could be done to eliminate competition in such grades as linguistic and clerical staff, and there is room for co-operation in arranging preliminary competitive examinations for candidates offering themselves specifically for different organisations, as well as in the standardization of forms of application and in interviewing by common recruiting officers.

Security of tenure is governed by staff regulations, ranging from temporary contracts which carry a month's notice at any time, without cause assigned, with an indemnity payment varying with the length of service, to appointments of indeterminate length, subject to review every five years only on grounds of efficiency, and terminable, apart from misconduct, only on grounds of inefficiency, abolition of the post, or lack of budgetary provision. The feeling of insecurity from which many members of the staff apparently suffer is not due only to the absence of proper staff regulations over the whole secretariat; it arises no less from the uncertainty of the political atmosphere and from the inconsistencies of national delegations. An urgent necessity in almost every department of the United Nations and the Specialized Agencies is a survey of the qualifications of temporary staff applying for permanent appointments, and all staff members should be given a definite decision either on the security of their jobs or on the date of their termination. The staff regulations of the United Nations also provide for filling vacancies by promotion rather than by an outside appointment, "with due regard to the maintenance of the staff on as wide a geographical basis as possible and without prejudice to the inflow of fresh talent at the various levels". All the awkward practical questions are left to be worked out; but most organisations have now developed a more or less clearly defined system of promotion. If these systems can be given adequate publicity, there should be less ground for dissatisfaction among those who might otherwise feel that their qualifications have been overlooked when senior posts fall vacant.

The broadsheet deals briefly with the general questions of co-ordination and notes the limited possibilities of interchange of officials between the United Nations and the Specialized Agencies, in spite of the undoubted advantages that a regular interchange would offer. The importance of staff consultation is also noted, but consideration of salary scales is deliberately omitted, important though this question is. Like some other matters which have been discussed, it bears closely on the important question of the morale of the secretariat staffs. This undoubtedly is not always as high as it should be; but even more than on the security factor, it depends on the conviction of each individual member of a secretariat staff that his job is worth doing. That, however, depends on the whole question of the functions of the secretariats and their relations with the policy-making bodies which are discussed in the second broadsheet.

Broadsheet No. 307 starts with a discussion of the general factors enhancing or limiting the influence which a secretariat may wield, and then examines in greater detail the part that can be played by a secretariat in the formulation of policy, in discussions at conference, in the preparation of budget estimates and in the execution of conference decisions. The broadsheet brings into clear relief some of the features which distinguish an international secretariat from a national Civil service, notably the fact that it serves a collection of governments, or government representatives, who lack a common tradition and a common outlook, and who meet infrequently. This situation affords a secretariat great scope for initiative, and it appears that many are already closely concerned in the making of policy. Here technical competence is a fundamental condition if the initiative of a secretariat is not to be ignored or regarded with suspicion.

The technical competence of an international secretariat, moreover, means not only efficiency in the usual sense but also the possession of a sound political judgment. *Planning's* observations on this particular point deserve careful attention from the many scientific workers who are now in one way or other concerned with the activities of the numerous international scientific bodies. A secretariat, P E P remarks, needs to be keenly aware of the wider implications of any problem under discussion and to be able to judge whether a possible proposal or suggestion is likely to be generally acceptable to governments.

That is true at other levels, as is the observation that a secretariat may frequently be in the best position to suggest alternative priorities to its policy-making organ, if this means suggesting the postponement of agreed projects. Experience drawn upon in this study leads *Planning* to suggest that intuition is not enough to enable a secretariat to distinguish between rashness and boldness, between a passion for immediate results and a disciplined enthusiasm. In the field of science, it is probably true that more harm has been done through the failure to provide a proper secretariat at all than from undue initiative on the part of such a secretariat. International scientific conferences, moreover, have on occasion suffered through being served by extremely amateur secretariats. Experience of the numerous permanent international scientific bodies now in existence should also induce those scientific men with experience of them to endorse the concluding remark of the broadsheet, that competence and sound judgment can be developed only if they are consciously pursued as objectives.

OPENING OF MILK BOTTLES BY BIRDS

IN 1921 birds described as tits were observed to prise open the wax-board tops of milk bottles on the doorsteps in Swaythling, near Stoneham, Southampton, and drink the milk. This is the first known record of an act which has now become a widespread habit in many parts of England and some parts of Wales, Scotland and Ireland, and which has to date been practised by at least eleven species of birds.

The spread of the habit is interesting, because of the problems of behaviour involved. How far did the individual birds learn the habit from each other, or invent it for themselves? If most of them learnt it, by what process did they do so? How did, and how do, they detect the presence of food inside the bottle?

These are the questions which James Fisher and R. A. Hinde pose in a recent article in *British Birds* (42, No. 11; November 1949), and although the writers agree that proper answers to the questions can be obtained only from carefully controlled experiments on birds of known history, it is submitted that much useful information can be derived from the collection of facts about the spread of the habit from members of ornithological societies and from the general public.

Some four hundred records have already been obtained about bottle-opening by species of tits, while to a lesser extent observations have also been made with house-sparrows, blackbirds, starlings, robins, chaffinches and hedge-sparrows.

Occurrence of the habit is naturally limited primarily by whether or not milk is distributed in bottles in the district. There is, however, good evidence in many cases that the habit may not develop in a district for several years after the use of bottles has become almost universal there—this is known to have been the case in at least twenty-three out of thirty districts where the year in which milk bottles were actually introduced is more or less accurately known.

Most British tits, and certainly the British species known to open milk bottles, namely, the great tit (*Parus major*), the blue tit (*P. cœruleus*) and the coal tit (*P. ater*), are resident and do not normally move, even in winter, more than a few miles from their breeding place. It would seem, therefore, that new centres and records more than fifteen miles distant from any place where the habit has been recorded previously probably represent new 'discoveries' of the habit by individual birds. The distribution of the records is consistent with the view that the new source of food was actually discovered *de novo* by only a small proportion of a local tit population and then passed on in some way to other individuals. In England and Wales, it seems likely that the habit has arisen *de novo* at least once per vice-county and may have arisen more often than this. It might be argued that the pattern of distribution of the observations reflects simply the view of the observers. In densely populated areas there are, of course, more observers ; but there are, similarly, more milk bottles. Further, there are many densely populated areas from which no record of the habit has yet been received or from which negative records have been received. Moreover the time interval between the introduction of milk bottles and the first occurrence of the habit makes this argument unsound. The evidence that the area in which the habit occurred, as well as the actual number of records, increased more rapidly each year, is enough to support the view that when the habit has been acquired by one tit it can then be spread through the population by some form of imitation or learning.

Many observations have been made about the actual method of opening the bottles. Although the habit occurs throughout the year, it is more prevalent during the winter months than in the summer. This may be due to the increased need which the birds have for fats during severe weather ; but many observers record that tits are much more common in winter in urban areas than they are in summer, and this is of importance. The bottles are usually attacked within a few minutes of being left at the door. There are some reports of parties of tits following the milkman's cart down the street and removing tops from bottles in the cart while the milkman is delivering milk to the houses. The method of opening the bottles varies greatly. When the milk bottle is closed by a cap of metal foil the bird usually first punctures the cap by hammering with its beak and then tears off the metal in thin strips. Sometimes the whole cap is removed and sometimes only a small hole is made in it. Cardboard caps may be treated in a variety of ways. The whole top may be removed, or only the press-in centre, or the cardboard may be torn off layer by layer until it is thin enough for a small hole to be made in it ; the milk may be taken through this hole or the bird may insert its beak in the hole and flick off the remainder of the top. The records show that several different methods may be used in any one district, and that more than one method may be employed by one individual.

In many areas bottles containing milks of different grades are distinguished by having caps of different colours. No less than fourteen observers who had milk of more than one type delivered at the house reported that the tits attacked only bottles of one type, and four others reported an almost invariable preference for one type.

Without experimental evidence it is impossible to decide which senses are of use to the bird in indicating the presence of food. Several correspondents have found that bottles filled with water or even empty bottles are still attacked ; but this conveys nothing if the previous history of the birds is not known.

To what extent it would be correct to refer to the behaviour of those individuals which 'invented' the habit for themselves as 'insight learning' is a problem which cannot be resolved with the present inadequate data.

T. H. HAWKINS

NEW "BRITISH STANDARDS" IN AGRICULTURE

THREE booklets* have recently been published by the British Standards Institution, each of which specifies standards in a particular field of agriculture. The first booklet, "Sampling Milk and Milk Products", was originally published in 1938 ; but improvements in sampling technique have made necessary a revision. The new version of the Standard emphasizes strongly the difficulty of obtaining an adequate sample of a bulk of material, especially if the bulk consists of a large number of small packages. Careful attention to details of the sampling is essential if the analytical results based upon the samples are to have any validity. Standard 809 : 1949 describes the techniques for obtaining samples from milk, cream, butter, cheese and other milk products, but is not concerned with the methods by which these samples are to be tested. That it contains no reference to the statistical aspects of the problem of sample selection is surprising ; for example, rules are given for the extraction of small samples from cheese, but no mention is made of the admittedly difficult problem of ensuring that the sample shall give an unbiased and reasonably precise estimate of the qualities measured.

The second booklet specifies performance tests intended to ensure a high standard for rubber used in milking machines, without placing restriction on the type of rubber, and to encourage uniformity between successive batches of rubber parts. The present version of Standard 1578 : 1949 relates only to natural rubber ; but it is intended to include synthetic rubbers in a revised version as soon as sufficient experience of them has been gained.

The increasing interest in the use of vitamin D_3 solutions for the enrichment of poultry mashes has made desirable the specification of standard solutions suitable for incorporation in poultry food. The new Standard 1581 : 1949, "Vitamin D in Oil for Poultry Feeding Purposes", recommends a sampling according to British Standard 627, followed by a biological determination of potency according to British Standard 911, in order to ensure that the vitamin D_3 content shall be either at least 200 B.S.I. units, or at least 400 B.S.I. units per gram. The Standard also describes the procedure to be adopted in the determination of acidity, for which an upper limit of 2 per cent (expressed as oleic acid) is specified.

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[*] Sampling Milk and Milk Products (British Standard 809 : 1949). Pp. 20. 2*s.* 6*d.* net. Rubbers for Milking Machines (British Standard 1578 : 1949). Pp. 8. 2*s.* net. Vitamin D in Oil for Poultry Feeding Purposes (Types 200 and 400) (British Standard 1581 : 1949) Pp. 10. 2*s.* net. (London: British Standards Institution, 1949.)

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Production of Amino-acids in Synthetic Media by *Escherichia coli* and *Aerobacter aerogenes*

STUDIES of the effect of glutamate and aspartate on the lag phase[1,2] and the early logarithmic phase[3] of *Escherichia coli* and *Aerobacter aerogenes* growing in a basal glucose – ammonium salt medium have suggested that these amino-acids and related non-nitrogenous compounds are important as intermediates necessary in cell division. This function is also emphasized by the work of Lwoff and Monod[4] and Ajl and Werkman[5], who have studied their use to replace the carbon dioxide requirement of bacteria growing in synthetic media. Morrison and Hinshelwood[1], using paper chromatography, have reported traces of glutamate and aspartate, in cultures through which air of normal carbon dioxide content was bubbled, after an approximate ninety-fold concentration of the liquid.

We now wish to report that the presence of amino-acids can be shown, without previous concentration, in filtrates from *E. coli* and *A. aerogenes* grown in unaerated conditions; for aerated cultures the quantities were considerably reduced. The presence of relatively large concentrations of salts in the synthetic medium renders difficult the direct identification of the amino-acids under these conditions, however. On concentrating ten times and adding an equal volume of ice-cold ethanol, most of the salt was removed, with the loss of some ninhydrin-positive material, and it was then possible by means of paper chromatography to demonstrate the presence of glutamic acid. The investigations were then extended by evaporating down to dryness, under reduced pressure on a water-bath, 1 litre of filtrate from a culture of *E. coli* grown without aeration in the glucose–ammonium salt medium. The residue was ground up with a glass rod under cold ethanol (20 ml.) and the amino-acid solution so obtained was examined. A chromatogram is shown in Fig. 1. By 'marking' with known amino-acids as well as by two-dimensional chromatography using acetic acid – butanol and pyridine – butanol mixtures, it was shown that spot *A* probably contains histidine, *B* aspartic acid, *C* glutamic acid and *D* alanine.

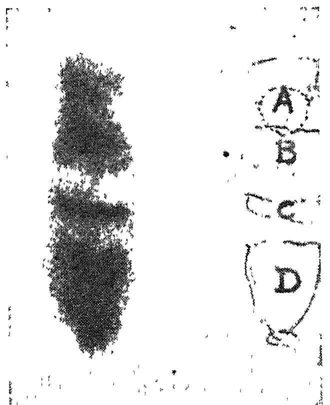

Fig. 1. Relevant portion of paper chromatogram of ethanolic extract of residue of filtrate from *E. coli* culture in glucose–ammonium salt medium. Solvent: butanol–acetic acid

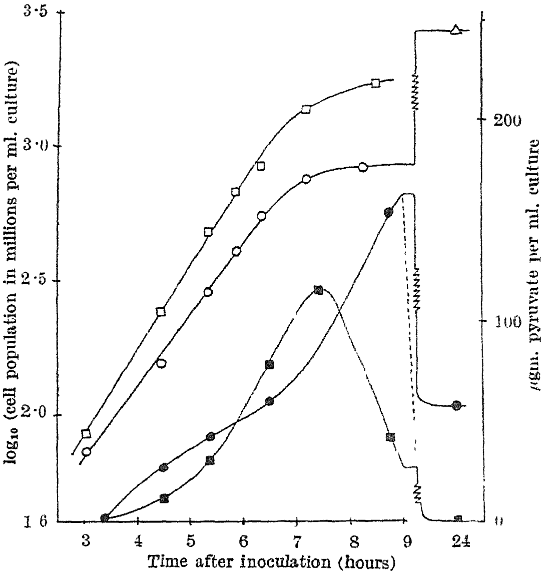

Fig. 2 Pyruvic acid production of *A. aerogenes* during growth in glucose – ammonium salt medium. Aerated: □, log (cell population); ■, pyruvate concentration. Unaerated: ○, log (cell population); ●, pyruvate concentration. Aeration at 9 hr. of previously unaerated culture produced increase in stationary population indicated by Δ and fall in pyruvate concentration shown by dotted line

In these experiments filtrates were examined in the early stationary phase of the bacteria, and the colour developed with ninhydrin was most marked when ammonium salt was present in excess of growth requirements. It has been established[6] for *E. coli* that deamination of some amino-acids is an aerobic process, and the difficulty of proving their presence on aeration may be due to the fact that in such cultures equilibrium in the stationary phase would be in favour of the formation of the keto-acids from which they are derived. We have accordingly examined the production of pyruvic acid, the main keto-acid present, during growth of *A. aerogenes* with and without aeration. The toluene extraction method was used[7], which is highly specific for pyruvic acid, and the results are shown in Fig. 2. It is seen that although the amount of pyruvate increases during the growth of an aerated culture, it falls fairly rapidly to zero as the stationary phase begins. The level of pyruvate reached in an unaerated culture is higher and the fall in concentration in the stationary phase is much less pronounced. If such a culture is aerated, however, the pyruvate disappears.

It would appear, therefore, that aeration favours not only the deamination of certain amino-acids, but also the destruction or utilization of their corresponding keto-acids. This may be related to our observation that, when the glucose in the basal medium is replaced by pyruvate or α-keto-glutarate (or by malate or succinate), the stationary population reached by our strain of *A. aerogenes* in unaerated cultures is much less than when aeration is provided. Increased crops on aeration have been reported for a variety of media, and have sometimes been ascribed to the oxidation and removal of toxic products accumulating when air is absent. The present work, together with our observation[3] that filtrates from unaerated cultures are able to stimulate growth when oxygen is available, suggests that *E. coli* and *A. aerogenes* are capable of utilizing certain products of metabolism only when the supply of oxygen is maintained.

We wish to thank Dr. D. A. Hall and Mr. E. S. Holdsworth for helpful advice in connexion with chromatography.

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Biochemical and Nutritional Significance of the Reaction between Proteins and Reducing Sugars

It has long been known that amino-acids and reducing sugars react when heated together in concentrated aqueous solution (the Maillard reaction), probably first by interaction between the amino- and aldehyde-groups, and afterwards by a complicated series of changes leading to darkening, evolution of carbon dioxide and the formation of tarry products. A similar kind of reaction occurs with proteins, and we have recently been able to isolate the first stage of the process and to demonstrate that, under very mild conditions (approximately 13 per cent moisture, neutral *p*H and 37° C.), as much as 7 per cent of reducing sugar can be firmly bound to a protein—almost entirely at the free amino-groups—without impairing its colour or solubility.

The biochemical properties of such protein-sugar complexes have not so far been examined in any detail, nor has it been ascertained whether or not they occur pre-formed in Nature. The possibility of the existence of amino-sugar linkages of this type in mucopolysaccharides, mucoids and glycoproteins, however, cannot be ignored, and there is no doubt that they can readily arise as artefacts during the handling or storage of materials of biological origin. A fall in free amino-nitrogen believed to result from an amino-sugar interaction has, for example, been reported during the storage of a concentrated liver extract rich in free amino-groups and glucose[1], and the amino-sugar complexes are known to give an Ehrlich reaction with *p*-dimethylaminobenzaldehyde similar to that given by the N-acetyl hexosamines[2,3], as well as to reduce dyes such as the 2 : 6-dichlorophenolindophenol used for the estimation of ascorbic acid. On such grounds alone the reaction is worthy of wider study.

The protein– (or amino-acid–) sugar reaction has been shown to be of great importance in the chemistry of food, and is now believed to contribute to many changes, some desirable, some undesirable, during cooking, processing and storage. Effects of practical significance as evidenced by the storage of skim-milk powder[4] include the development of unpleasant flavours and of brown discoloration, and loss of biological value of the protein. The fact that the reaction has a high temperature coefficient and proceeds most rapidly when the reactants are in equilibrium with an atmospheric relative humidity of 65–70 per cent[5] makes deterioration of this type of particular significance in dried and concentrated foods and in warm climates.

In our investigation of the mechanism of the reaction, a solution of sodium caseinate and glucose at *p*H 6·3 was freeze-dried, and the finely divided product (containing 31 per cent glucose on the dry basis) held at 37° C. in equilibrium with an atmosphere at 70 per cent relative humidity. Three stages of interaction could be distinguished.

(1) During the first stage the free amino-groups of the protein (consisting mainly of the ε-amino-groups of the lysine side-chains) reacted rapidly with the glucose, leading to a ratio of glucose bound to amino-groups destroyed of but little more than 1 : 1. After five days, approximately two-thirds of the amino-groups had reacted and the product was still white and of unimpaired solubility. The powerful reducing properties of the product and the fact that none of the glucose could be recovered by acid hydrolysis shows that the glucose-amino-group linkage cannot be that of a simple N-glycoside. Isomerization of a first-formed N-glycoside to an *iso*glucosamine (with a mono-substituted amino-group at carbon 1 and a carbonyl group in position 2) by the Amadori rearrangement[6] would explain the reducing properties and resistance to hydrolysis of the complex, and part at least of its behaviour with the Ehrlich reagent; but such a suggestion at present can only be speculative, and the precise structure of the complex still awaits elucidation.

(2) As the reaction continued, progressively more carbohydrate combined with the protein than could be accounted for by combination with free amino-groups, and other of the 'essential' amino-acids in addition to lysine became involved. After thirty days, when the protein-sugar complex had become somewhat brown in colour and of low solubility over a wide *p*H range, approximately 90 per cent of the lysine, 70 per cent of the arginine and 30 per cent of the histidine were shown to have reacted. Approximately a half of the methionine and one-third of the tyrosine had probably also disappeared. Hydrolysis by acid liberated all the combined methionine, most of the tyrosine and 70 per cent of the lysine, but none of the arginine or histidine. There was no demonstrable loss of tryptophane or of total acidic or amide groups. Total basic groups estimated by dye-absorption or alcohol-titration were practically unchanged, the basic group – sugar combination apparently still possessing basic properties. Cystine and glutamic acid estimated after acid hydrolysis also showed no change.

(3) On still further storage the colour of the reaction-mixture became darker, dialysable products (non-glucose) appeared in increasing quantities, and the increase in weight of the protein tended towards a maximum. After 164 days, approximately one-third of the total glucose undergoing change had been converted into dialysable decomposition products, and the protein – sugar complex contained nearly 20 per cent of bound carbohydrate.

At all stages of the reaction the increase in weight of the protein was approximately sufficient to allow for condensation of one molecule of glucose with each amino-acid side-chain inactivated; but no direct evidence has been obtained that this is, in fact, the method of combination. The exact nature of the groups combined with the various amino-acid side-chains, therefore, still remains to be determined. They could be (*a*) glucose itself, (*b*) reactive decomposition products of glucose or of the glucose-amino complex, or (*c*) cross-linkages with carbohydrate already attached to the amino-groups of the protein.

The experimental conditions used in this work were those shown to give a maximum rate of disappearance of the free amino-groups[5,7], the water and glucose contents being consistent with a picture of the reaction as taking place in a monolayer at the surface of the protein. At higher water-contents, degradation and browning are accelerated, and this may well account for the failure of other workers to distinguish the earlier stages of the reaction.

The work described above was carried out as part of the programme of the Food Investigation Organisation of the Department of Scientific and Industrial Research.

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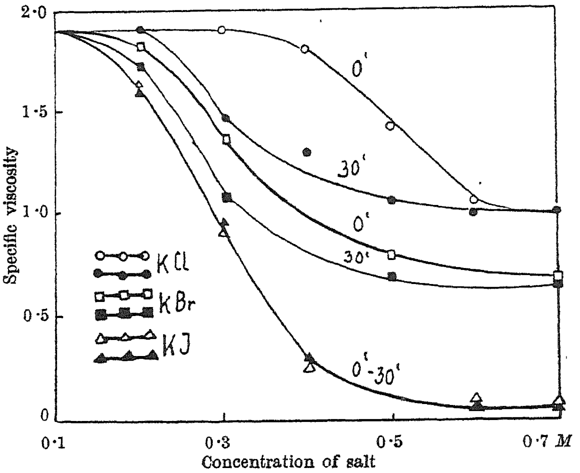
Effect of Halogen Ions on *F*-Actin

I HAVE investigated the behaviour of polymerized actin in different concentrations of potassium chloride, bromide and iodide respectively.

The actin was prepared in the following way. Rabbit muscle was minced and the myosin extracted with acid potassium chloride–phosphate[1]. The muscle residue was washed in an equal volume of distilled water and suspended in five volumes of 0·4 per cent sodium bicarbonate at room temperature. After 30 min. it was pressed through a cloth and kept overnight in a refrigerator at −12° C. Then it was suspended in an equal volume of acetone and pressed through a cloth. It was stirred again in an equal volume of acetone and allowed to stand for 10 min. The acetone was removed by pressing through a cloth and by drying at room temperature. The actin was extracted from the muscle residue following the method of F. B. Straub[2]. The water solution obtained by this method contained 7 mgm./ml. actin in the globular form. When the salt concentration was brought to 0·1 *M* after standing for 15 min. at room temperature, it was entirely polymerized, being transformed to *F*-actin. The *p*H of the solution was 1.

The polymerized actin was cooled to 0° C. Samples were taken out and their salt concentrations brought to 0·3, 0·4, 0·5, 0·6 *M* with potassium chloride, bromide and iodide respectively. Determinations were made immediately after the salt concentration was adjusted, and again 30 min. later. Meanwhile, the samples were allowed to stand at 0° C. The qualitative double refraction of flow and viscosity were examined. The modified Ostwald viscosimeter was used[3]. It was found that double refraction of flow and viscosity decrease with increasing salt concentration. This increase is most obvious using the iodide ion, where the double refraction of flow disappears when the concentration of salt reaches 0·5 *M* and the viscosity drops almost to the viscosity of the pure salt. Results of the measurements are shown in the accompanying graph.



Each anion examined is able to polymerize actin in 0·1 *M* concentration. As shown by the graph, the disintegrating effect of iodides is instantaneous, as proved by the disappearance of double refraction of flow. If we remove the salt by dialysis, polymerized actin is transformed into the globular form. This transformation is reversible. Iodide-treated actin, however, after being dialysed, cannot be transformed again into its *F*-form. The disintegrating effect of halogen ions is probably connected with their oxidizing properties[4].

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Vitamin B_{12} and Histamine

SINCE evidence has been accumulated that a release of histamine, or histamine-like substances, accounts, completely or partially, for anaphylactic shock in animals[1], an attempt has been made to find out whether vitamin B_{12}, which has been shown to possess a protective action on anaphylactic shock in the guinea pig[2], could also have an anti-histaminic activity. Vitamin B_{12} has therefore been tested on guinea pigs in which a histaminic shock was provoked; as source of vitamin B_{12}, 'Rubramin' (Squibb) vials of 15 γ have been used.

Of twelve guinea pigs (mean weight 300 gm.) four, used as controls, were injected intracardiacally with 0·12 mgm. of histamine (which is almost twice the M. L. D. of 0·025 mgm. per 100 gm. body-weight by intravenous injection[3]), and all of them died of shock within half an hour. The other eight were injected intraperitoneally with 15 γ of vitamin B_{12}, and 15 min. later each of them received, as in the controls, 1 mgm. of histamine intracardiacally. None of them died; but very slight signs of shock were observed. These experiments, although limited, show that the vitamin B_{12} is effective, even if used in very small doses, in protecting the guinea pig from an undoubtedly lethal dose of histamine. Further, I had the impression that the same quantity of 'Rubramin' was, with the guinea pig, more effective in the histaminic than in the anaphylactic shock.

In an attempt to explain the mechanism of action of the vitamin B_{12} in this case, the first step was to see whether or not a direct inactivation of the histamine might be considered. 1 c.c. of 'Rubramin' (15 γ) was mixed in a test-tube with 1 mgm. of histamine, and then left in an incubator for 24 hr. at 37° C.; also 1 ml. of distilled water was mixed with the same quantity of histamine and left for the same time in an incubator at the same temperature. This solution was used as control. Strips of guinea pig intestine were placed in a Tyrode bath at 37° C. and connected with a Marey drum to record contractions. These strips of intestine so prepared failed to show any appreciable difference in contraction response when either the vitamin B_{12}–histamine solution or the distilled water–histamine solution was added. Hence I am inclined to rule out any direct inactivation of the histamine by vitamin B_{12}; for otherwise the solution containing vitamin B_{12} should have given a much-decreased contraction response.

Another possibility is activation of the histaminase by the vitamin B_{12}. That pre-treatment with histaminase can prevent anaphylactic shock in the guinea pig has been shown (Karady and Browne[4]), although not confirmed by Alexander and Donald Bottom[5]. Eight guinea pigs were therefore sensitized with 1/10 horse serum intraperitoneally. After fifteen days, they were given 30 γ of vitamin B_{12} intraperitoneally and immediately afterwards 0·3 gm. of sodium benzoate intramuscularly. (The sodium benzoate was given because it has been shown[6] to inhibit histaminase completely at the concentration of 0·1 per cent.) Finally, fifteen minutes later, the shock-producing injection of 1 ml. of horse serum was given. All the guinea pigs survived, showing only slight signs of shock.

These results indicate that the vitamin B_{12} does not activate the histaminase; indeed, if this were the case, the injected sodium benzoate inactivating the histaminase should have annulled the protective action of the vitamin B_{12}, and the guinea pigs should have died of anaphylactic shock. Since 'Rubramin' seems to act on the histamine neither directly nor indirectly by interference with its metabolism, its mechanism of action seems to be competitive antagonism as in the case of the common antihistaminic drugs.

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[1] Bartosch, Feldberb and Nagel, *Arch. ges. Physiol.*, **230**, 129 (1933). Schild, *Proc. Soc. Exp. Biol. and Med.*, **42**, 494 (1939). Code, *Amer. J. Physiol.*, **127**, 78 (1939).

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Dispersion of the Birefringence in Barium Titanate

THE birefringence of barium titanate has been measured over the range 4000–7000 A. Our attention was first directed to this work by the impossibility of obtaining the correct colour sequence in compensation methods of measurement, and the disagreement of birefringence values calculated from the apparent compensation points and those found by other methods[1].

The crystals used were of the flat-plate type with dimensions of the order 0·5 × 0·5 × 0·1 mm., containing a single twin boundary running parallel to the plate edge and at 45° to the larger surface. When viewed between Nicols crossed at 45° to their edges, the crystals exhibit a system of fringes on the twin boundary, marking out contours of equal relative retardation. The area with *c*-axis (optic axis) perpendicular to the plate is effectively isotropic, and thus always appears dark.

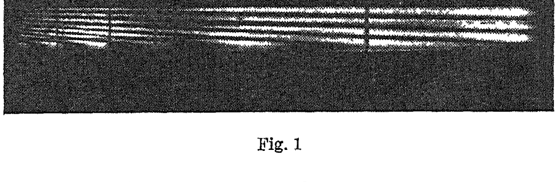

Fig. 1

The birefringence was first investigated using Wratten filters and white light. A marked dispersion was evident; but accurate measurements were not possible because of the wide frequency-band passed by these filters.

To overcome this difficulty, the overlapping coloured fringes obtained in white light were analysed by a grating spectrometer. The method is similar to that of 'crossed dispersion' in interferometry[2]. Light from a carbon arc was focused on the crystal, which was clamped on the stage of a projecting microscope between crossed Nicols in the 45° position. The crystal was oriented by rotation of the stage to produce a horizontal fringe system, which was focused on the vertical slit of a grating spectrograph.

A typical spectrogram is shown in Fig. 1. The number of fringes increases rapidly from the red end of the spectrum, fresh fringes running in from the birefringent side of the twin boundary. With suitable corrections for variation in magnification of the microscope with frequency and distortions in the

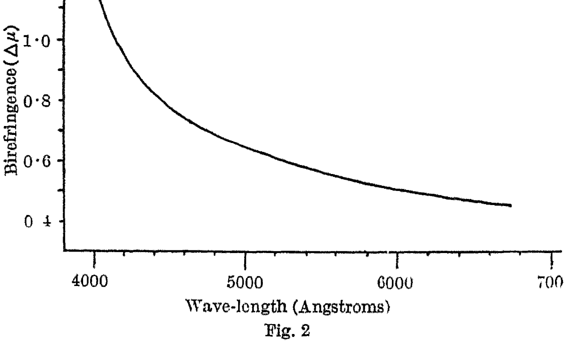

Fig. 2

subsequent enlargements, the birefringence can be calculated from the fringe separation, a helium spectrum being used to calibrate the grating dispersion.

From the shape of the birefringence – wave-length curve (Fig. 2) there would appear to be an absorption frequency at about 3800 A.

Further work is in progress to extend the range of the measurements to the ultra-violet.

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[1] Cross, L. E., *et al.*, *Nature*, **163**, 635 (1949).

[2] Williams, W. E. "Applications of Interferometry", 102 (Methuen, 1941).

Aperiodic Frequency-Doubling by Means of 'Pluri-Terminal' Titanate Capacitors

As is well known, titanate ceramic dielectrics show a pronounced dependence of permittivity upon applied A.C. or D.C. field-strength, due to dielectric saturation and hysteresis.

We felt that this permittivity variation should exist not only for superimposed fields having the same direction as the original 'measuring' field, but also for fields applied at right angles. We have been able to confirm this assumption by means of a new four-terminal capacitor element, which consists of a small cube or parallelepiped of titanate ceramic, four (or all) faces of which are partially metallized. Pairs of opposite electrodes may be considered as independent capacitors which can be energized by separate voltage sources.

Measurements were made for the two alternative cases: (*a*) *crossed fields:* one pair of electrodes connected to the measuring device (for example, a conventional Schering bridge); the other orthogonal pair receiving the variable A.C. or D.C. voltage; (*b*) *parallel fields:* the variable polarizing voltage is impressed on the same pair of electrodes used for measurement, leaving the second pair disconnected.

The experimental results show that the capacitance variation as a function of the applied voltage has substantially the same order of magnitude in both cases.

To cite a typical example among the various practical applications of non-linear, pluri-terminal capacitor devices, we have developed an aperiodic frequency-doubling circuit. The basic circuit diagram using a four-terminal titanate capacitor is represented in Fig. 1. Applying to the input electrodes a voltage of suitable frequency and increasing this voltage beyond a critical value, one observes in the output electrodes an increasing second-harmonic distortion. Impressing now a D.C. polarization of suitable value upon the element, a nearly complete suppression of the fundamental frequency is obtained without filtering, and the second harmonic attains a good sinusoidal waveform.

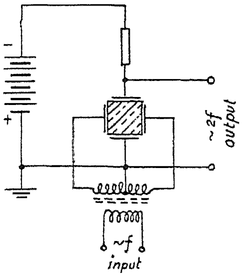

Fig. 1

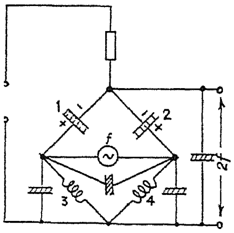

Fig. 2

Obviously the frequency-doubling depends upon the second-harmonic distortion caused in the non-linear circuit elements by the D.C. polarization; this may be more easily understood by considering the circuit as a four-arm bridge including the stray capacitances between adjacent electrodes, as shown in Fig. 2. If the bridge is balanced, the current of fundamental frequency disappears in the output; but the double-frequency current does not, because the D.C. polarization in branches 1 and 2 is of opposite sign.

Although the frequency-doubling was originally demonstrated with four-terminal capacitors, it can also be obtained just as well with three-terminal elements (in the form of disks, plates or tubes) and even with two separate two-terminal elements.

Frequency-doubling could be obtained also when the D.C. polarization was temporarily applied and then removed. Since the delay time is quite large, it is possible to apply the polarizing voltage in the form of pulses or as a practically static charge. The above-mentioned results have been partly communicated in a paper read at the National Convention of the Institute of Radio Engineers held at New York in March 1949.

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Superconductivity of Uranium

FOLLOWING Justi's discovery[1] of the superconductivity of uranium at 1·3° K., one of us[2] found, on the basis of magnetic measurements, that a specimen of pure uranium did not become superconducting down to 1·08° K., and suggested that Justi's results, which were based on resistance measurements, were due to traces of a superconducting impurity. It is now probable that this interpretation is incorrect, in view of the following new results.

Alekseevski and Migunov[3], also using the magnetic method, found that some uranium specimens became superconducting at 1·3° K., but that less pure specimens did not, down to the lowest temperature tried. This led us to examine a wider variety of specimens by the magnetic method, and we did indeed find that one sample became superconducting at about 1·3° K. (the transition was spread over about 0·2° K.), though this was *less* pure than the samples which did not become superconducting. More recently, we have taken two of the specimens which failed to become superconducting in the helium-range down to lower temperatures by the adiabatic demagnetization technique, using the method developed by Mendoza[4], and found that they both became superconducting at about 0·75° K., the transition again being spread over about 0·2° K. It therefore seems probable that uranium is indeed a superconductor, but has different transition temperatures according to the purity of the specimen. The recent results of Heer and Daunt[5] point to a similar situation for titanium.

In the course of the experiments, it was found that rather large magnetic fields (of order 2,000 gauss per deg. K. below the transition temperature) were required to destroy the superconductivity of all the samples. The destruction was spread over a wide range of fields, and the detailed magnetization curve varied from one sample to another, so the figure quoted is only an order of magnitude. If such high fields were true thermodynamic critical fields, and varied with temperature in the usual parabolic way, the electronic specific heat of normal uranium at low temperatures would have to be as high as 8,000 T ergs/gm./° K. Some rough measurements of the specific heat between 1° K. and 4° K. suggest that the electronic specific heat is at most 600 T ergs/gm./° K., so it is probable that the observed high fields are not, in fact, true critical fields, but of the same nature as the apparent high critical fields of impure superconductors.

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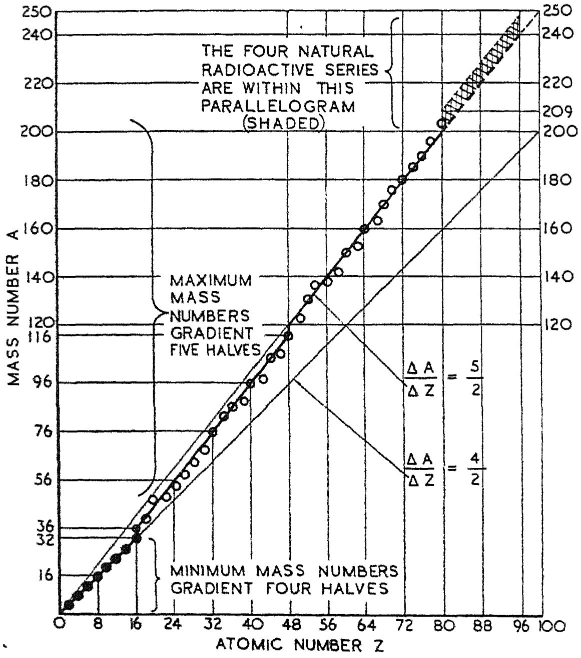
Maximum Mass Numbers of Stable Nuclei

THE importance of the maximum mass number of a stable nucleus resides in its obvious correlation with the structure of completed nuclear shells.

When mass numbers of nuclei are plotted, as in the accompanying diagram, against their atomic numbers, two reference lines may be drawn, radiating from zero, one with a slope of two, and the other with a slope of five halves. From $Z = 0$ to $Z = 16$, the *minimum* stable isotopes have, as is well known, a gradient of exactly 2, and from $Z = 16$ to $Z = 72$ the *maximum* stable isotopes have a gradient of five halves.



There are sudden and significant discontinuities of four mass units at $Z = 16$, 48 and 80. Also, at $Z = 72$, the gradient changes temporarily from five halves to six halves.

The range $Z = 80$–96 embraces all the heavy natural radioactive elements, and the line of maximum mass numbers retains its gradient of five halves with a maximum difference of nine units above the reference line.

The general geometry of the data is clearly shown in the diagram. The most striking feature is the retention of the gradient of five halves, which demands that for an increment in Z of 2 units of charge, there is an increment of A of 5 units of mass. As two of the mass units are necessarily protons, the other three mass units must be neutrons.

It would appear reasonable to infer that a saturation field may exist between an alpha-particle and a neutron.

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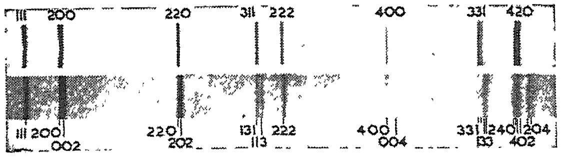
Structure of Monoxides of some Transition Elements at Low Temperatures

IT has been shown by one of us[1] that, at ordinary temperatures, the structure of nickel oxide is slightly deformed from face-centred cubic symmetry. Later work[2] proved that at − 180° C. an increase in the rhombohedral deformation occurs. On the other hand, it was found that the departure from cubic symmetry vanishes at a temperature of about 200° C.

X-ray powder photographs of the monoxides of iron and cobalt disclose no abnormal structural features at room temperatures. Recently, abnormalities in the structure of a mixed monoxide of nickel and cobalt have been noticed, and it was thought desirable to examine the behaviour of this monoxide and of the monoxides of cobalt, iron and manganese at low temperatures. Some interesting changes have been observed.

In order to carry out the investigation, a 19-cm. diameter powder camera of the conventional type has been modified, and the principle devised by Lonsdale and Smith[3] applied to obtain complete X-ray powder photographs at liquid-air temperature. Slight changes of the equipment enabled photographs to be obtained at approximately − 70° C. An extension of the technique to include a temperature of approximately − 110° C. was also tried successfully.

Powder photographs of cobaltous oxide at liquid-air temperature and at room temperature (20° C.) are shown in the accompanying reproduction. At liquid-air temperature all reflexions show splitting or multiplicity except 111 and 222. The changes are consistent with a transition from the face-centred cubic arrangement such that the symmetry becomes tetragonal. The lattice parameters of the tetragonal structure cell are $a_0 = 4{\cdot}2552 \pm 0{\cdot}0005$, $c_0 = 4{\cdot}2058 \pm 0{\cdot}0005$ kX., $c/a = 0{\cdot}9884 \pm 0{\cdot}0001$ at − 180° C.



X-ray powder photographs (cobalt $K\alpha$ radiation, 19-cm. camera) of cobalt oxide: upper photograph, at 20° C.; lower, at −180° C.

There is a measurable structural deformation at −70° C., but the axial ratio of the tetragonal cell is only 0·995, thus differing from the 1·0 of a cubic cell by a smaller amount than at −180° C. At 20° C. the face-centred cubic cell had a lattice parameter $a_0 = 4{\cdot}2495 \pm 0{\cdot}0005$ kX.

The X-ray examinations of ferrous oxide disclose a rhombohedral deformation of the face-centred cubic arrangement below −70° C. The deformation thus takes a similar form to that found for nickel oxide, but the angle of the unit rhomb becomes less than 60° instead of greater.

Manganous oxide also shows below −100° C. a transition from face-centred cubic to a symmetry approximating to rhombohedral; the deformation at −180° C. is substantial.

It is hoped to describe this work in more detail elsewhere. Further investigations should yield some explanation of the changes in structure, which appear likely to be connected with the particular electronic configuration of the transition elements.

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Point Sources of Radio Noise

One of the unexplained phenomena of radio-astronomy is the existence of intense point sources of noise. These have been associated with the galaxy because they seem to be point sources within the accuracy of measurement, and because they have not shown pronounced parallax or proper motion. But the assumption of galactic or stellar origin fails to explain all the facts as understood now.

In the first place, although several point sources lie in the galactic plane, others are located at high galactic latitudes. Examples of these latter are the point sources in Hercules and in Coma Berenices. Furthermore, of the sources that lie approximately in the galactic plane, none has been definitely identified with optical objects, and none lies in the direction of the galactic centre.

Another major difficulty with the stellar or galactic hypothesis is the inverse-square decrease of intensity with distance from the source. For example, a source at the distance of the nearest star would have to radiate at a rate exceeding that of the sun by a factor of 10^{10} in order to produce the same noise intensity on the earth.

This last objection suggests that we should look within the solar system for the origin of these radio-noise sources. We must rule out the planets and asteroids as possible sources, if only because they are concentrated in the plane of the ecliptic and have huge proper motions and parallax angles. Giant comets, however, having distant aphelia, constitute a remotely possible explanation of the point sources. Their orbits may have almost any inclination to the plane of the ecliptic and hence to the plane of the galactic equator.

Recent solar studies indicate the existence of extreme ultra-violet and X-radiation, which would have an ionizing effect on gaseous media. A rough calculation shows that if the ionizing radiation from the sun were absorbed by a distant comet—at, say, 50 astronomical units—and re-radiated over a 1,000 Mc./sec. band, the resultant radio-noise intensity on the earth would be consistent with the observations. We very tentatively suggest that plasma-type oscillations of a gaseous ionized medium might be a mechanism for the conversion of the solar energy to the observed radio-frequency noise.

If comets are the point sources in question, only the very largest, long-period ones will fit the observations. Even so, it may be possible to observe an annual parallax of the order of 1°, and possibly also a small proper motion. We admit that this idea is highly speculative; but fortunately it is subject to direct experimental test. Detection of a measurable parallax would constitute a sufficient and necessary proof that the point sources of extra-terrestrial radio noise are part of the solar system.

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Induced Grid Noise and Noise Factor

It is easily shown that for any type of internal structure the power-frequency spectrum $s_g(f)$ of the current fluctuations appearing at the control grid of a triode valve is related to the spectrum $s_a(f)$ of the anode current fluctuations by

$$s_g(f) = \left|\frac{Y_g(f)}{g_m(f)}\right|^2 s_a(f), \qquad (1)$$

where $Y_g(f)$ is the increase, from the 'cut off' to the working conditions, of input admittance at the grid with the anode effectively earthed; g_m is the high-frequency mutual conductance of the triode. In the case of the 'induced' (transit-time) grid noise, and for moderate angles, the relevant component of grid admittance is largely susceptive, being

$$Y_{gt}(f) \doteqdot jB_t(f) = j.2\pi f.C_t.$$

where C_t is the value of the 'space-charge capacitance' measured on the valve. Thus, setting

$$s_a(f) = 2eI_a\Gamma^2$$

$$s_g(f) \doteqdot \left|\frac{j.2\pi f.C_t}{g_m}\right|^2 . 2eI_a\Gamma^2. \qquad (2)$$

The modifications to (2) introduced by distribution of electron velocities and trajectories are discussed elsewhere[1], and direct experimental verification is also described.

Applying (1) to the problem of noise factor of the common cathode triode, and assuming that all induced grid noise is correlated with cathode-anode shot noise, it is found that the minimum noise factor obtained on adjusting conductive and susceptive components of the 'source' (grid-ground) admittance is independent of cathode and anode lead inductance effects, space charge capacitance, transit-time damping and induced grid noise itself. Thus a circuit adjusted for minimum noise factor in the absence of these effects will function optimally when they are present. Such effects merely modify the input, output and transfer admittance of the stage without, to first order, affecting its noise factor.

We may immediately deduce, and it may be shown more formally, that in this hypothetical case the 'optimum detuning' at the grid required to minimize the noise factor is almost precisely the value of the space-charge capacitance C_t. In practice, the actual detuning required is found experimentally to be about 0·9 C_t. This discrepancy is due to the distributed nature of the correlation between induced grid currents and anode currents, the effects of which are generally explained by an artificial resolution of grid noise into completely correlated and completely uncorrelated components. The small deviation from C_t observed indicates that the 'uncorrelated' component is a small fraction only of the total induced grid noise, and need only be taken into account where great accuracy in estimation is required. Experiment shows that deviation of noise factor from values predicted from the simple treatment is detectable only in the region of operation where the grid is just about to take direct current, being then of the order of one or two per cent.

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[1] Bell, R. L., *Wireless Eng.*, [27 (March 1950)].

Truncated Normal Distributions

THE lognormal frequency distribution, a type of normal curve in which the abscissal scale is logarithmic instead of linear, is of very wide occurrence in many branches of pure and applied science[1]. A special case is the truncated lognormal distribution, recently noted in insect populations by Spiller[2]. I have found several instances of this distribution in ecological and bacteriological studies, and also in examples of accident statistics and word distributions given by Yule[3]. As the existence of this large class of distributions becomes more widely known, so will simple methods of dealing with them be required.

With frequency counts of Spiller's type, where negative values cannot occur, those observations which would normally be negative swell the total of zeros. The distribution is then truncated, with a discontinuity at the point of truncation. The only method of preventing truncation is to increase the size of the sampling unit so that zero values occur very rarely or not at all, in which case the distribution may be taken as a complete lognormal curve.

Mathematically, the frequency function of such a distribution (where x is assumed to vary continuously) takes the form

$$\left.\begin{aligned} y &= 0, & x &< a \\ &= \frac{1}{\sigma\sqrt{2\pi}} \int_{-\infty}^{a} \exp\left[-\frac{(x-\mu)^2}{2\sigma^2}\right] dx, & x &= a \\ &= \frac{1}{\sigma\sqrt{2\pi}} \exp\left[-\frac{(x-\mu)^2}{2\sigma^2}\right], & x &> a \end{aligned}\right\} \quad (1)$$

where $x = a$ is the point of truncation and μ, σ are the parameters of the parent normal curve. For discrete lognormal variation (with log $(n + 1)$ as the normalizing function to enable zeros to be plotted), the frequency of n counts per sampling unit can be written

$$y_n = \frac{1}{\sigma\sqrt{2\pi}} \int_{\log n}^{\log(n+1)} \exp\left[-\frac{(x-\mu)^2}{2\sigma^2}\right] dx. \quad (2)$$

For x greater than or equal to the point of truncation, the cumulative distribution function of (1) and the derived form (2) is the cumulative normal curve, which by definition becomes graphically a straight line when probits are taken as ordinates. For any practical distribution the best-fitting straight line to the cumulative observations estimates μ and σ, the mean and standard deviation of the parent normal curve. Objections to this method are that the accuracy of eye-fitted lines is always doubtful, and since successive points are not independent, probit regression methods are not applicable, and tests of significance are invalidated. Bliss[4] treats cases of truncation in time-mortality curves by computing corrections to preliminary graphical estimates; the objection relating to significance tests still holds, however, by reason of the non-independence.

An alternative method, which will be presented more fully elsewhere, is to equate the moments of the sample distribution to those of the theoretical model (1). These latter can be expressed in terms of μ, σ and a, and hence μ and σ may be found directly, obviating the necessity of transforming to probits and fitting straight lines. When applied to Spiller's distribution of red scale, this method gives values of 0·70 for μ and 0·55 for σ. A comparison of observed and expected frequencies is presented in the table, and the resulting value of χ^2 of 17·45 with 18 degrees of freedom has a probability of 0·50. There is thus no reason to assume any departure from normality in the sample.

No. of scales per leaf	Observed frequency	Expected frequency	No. of scales per leaf	Observed frequency	Expected frequency
0	89	73	10	13	18·1
1	79	95·7	11–12	31	30·2
2	78	78·1	13–14	29	23·2
3	58	62·3	15–17	24	26·7
4	51	50·9	18–20	19	19·7
5	30	40·7	21–25	28	23·2
6	39	34·3	26–35	30	26·5
7	34	28·6	36–50	20	22·2
8	27	24·5	51–	23	21·2
9	18	21·1			

Finney's[5] comments on Spiller's letter suggest that he has missed the implications of truncation. Truncation has the effect of raising the mean and lowering the standard deviation, the values quoted by Finney illustrating this; his graphical estimates are 0·70 and 0·53 for the parent curve, as compared with 0·774 and 0·487 from the original distribution. The two sets are not comparable for the purpose of testing agreement with the hypothesis of normality. Again, the criterion of size of mean relative to standard deviation does not apply to a truncated curve, as would be the case with a complete normal curve.

The technique explained briefly in this communication offers a solution to the problem of truncated normal distributions, and is preferable to the use of regression or iterative methods employing probits, both on the score of ease of analysis as well as ease of interpretation.

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[2] Spiller, D., *Nature*, **162**, 530 (1948).

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D. J., *Nature*, **162**, 898 (1948).

Heat-Flow Below the Oceans

PROF. HANS PETTERSSON has reported[1] measuring the geothermal gradient at two places in the deep-sea sediment below the Pacific Ocean. This work, done from the schooner *Albatross* of the first Swedish Deep-Sea Expedition, is apparently the first of its kind and is an important contribution to the study of the heat flowing from the interior of the earth.

As is well known, the amount of heat flowing across a plane surface in a thermal conductor is

$$h = -k \frac{\partial T}{\partial n},$$

where k is the thermal conductivity of the conductor and $\partial T/\partial n$ is the temperature gradient normal to the surface. During the past ten years, careful work has been done on the problem of determining the heat-flow to the surface of the *continents*. This is accomplished by measuring both the temperature gradients and the thermal conductivities of rocks of the same locality. It is beginning to appear from this work, carried out for South Africa[2], Britain[3], Persia[4], California[5] and elsewhere, that a normal heat-flow for a quiet (that is, non-volcanic) region of a continent lies in the neighbourhood of $h = 1 \cdot 2 \times 10^{-6}$ cal./cm.^{2}-sec., with likely departures of plus or minus about 20 per cent.

However, so far nobody has measured the heat-flow below the bottom of the oceans. It has been suggested[6] that this may be significantly less than the continental values, owing to the supposed partial or complete absence under the oceans of the granitic layer, the radioactive content of which evidently supplies a considerable fraction of the continental heat-flow. Prof. Pettersson, in solving the difficult problem of measuring the temperature gradient in deep-sea sediments, has made it possible to begin to determine heat-flow below the oceans. His two values of 22 and 26 metres per degree Centigrade give an average geothermal gradient of about 42° C./km., which he says is unexpectedly high[1].

It is true that this value would be somewhat high for a continent, but it has been shown in the past that heat-flow in the continents is considerably more uniform than either the conductivities or the geothermal gradients. For example, the mean of the heat-flows measured in Britain[3] is within 20 per cent of that for South Africa[2], even though the British geothermal gradients on which the calculations are based exceed those used in the determinations for South Africa by a factor of three or four. The close agreement of the heat-flows arises because the corresponding conductivities differ also by approximately this same factor.

Should the conductivity of the sediments in which Prof. Pettersson made his measurements of geothermal gradient be appreciably controlled by the conductivity of their water content, as seems not unreasonable, his heat-flows may well be less than the continental value; fresh water at 0° C. and atmospheric pressure has the low conductivity of $0 \cdot 0013$ cal./cm.-sec.-° C. Bridgman[7] has shown that a pressure of 1,000 atmospheres increases the conductivity of water by only some 6 per cent. It is, of course, unlikely that deep-sea sediments will prove to have so low a conductivity as that of water, owing to the presence of the solid material. However, a conductivity as high as about $0 \cdot 003$ cal./cm.-sec.-° C. would be necessary in order for the first two ocean heat-flows to be as great as the continental value. It is therefore by no means certain that the relatively high geothermal gradient of 42° C./km. also implies a high heat-flow under the oceans.

It is to be hoped that Prof. Pettersson will measure the thermal conductivities of some of his cores of sediment, collected from the same regions in which he measured the geothermal gradients, in order to find the local heat-flows. The results would be of great interest.

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Ocean Swell: its Decay and Period Increase

HITHERTO there has been a difference of opinion concerning the role of eddy viscosity in the behaviour of wind waves and swell. On one hand, Suthons[1] ascribes the lengthening of waves in sea and swell and part of the decay of swell to the effect of eddy viscosity. According to Suthons, waves become longer simply because viscosity tends to increase the depth of water affected by the wave motion, since it transfers kinetic energy downwards. This reasoning does not, however, seem convincing. Obviously, longer waves have greater depths of water affected by the wave motion; but this does not mean that, conversely, the waves would become longer if the depth of water having kinetic energy were increased by effects that have nothing to do with the mechanism of wave motion.

Sverdrup and Munk[2], on the other hand, neglected the effect of viscosity. They ascribe the decay and the period increase of swell entirely to the effect of air resistance, and Sverdrup[3] has presented theoretical computations in order to show that this effect gives rise to a selective damping, which acts in favour of the longer components of a wave spectrum.

The present communication gives a preliminary account of some computations and considerations which have led us to believe that eddy viscosity is of much more importance for the theory of ocean swell (and also for wind waves) than would appear from the work of Sverdrup and Munk. It is even possible to explain the decay and lengthening of ocean swell by means of selective damping by eddy viscosity alone, and the values of the viscosity coefficient which must then be used in order to obtain a satisfactory agreement with observed rates of decay and of period increase are quite reasonable and even rather small.

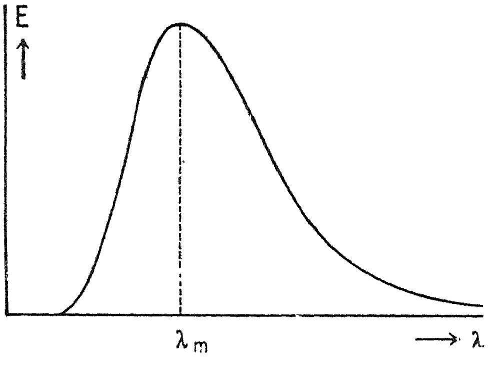
To show this, we must bear in mind that the eddy viscosity coefficient to be used depends on the size of the systems under consideration and is therefore larger for long waves than for short ones. According to Richardson's empirical results[4,7] and von Weizsacker's[5] recent theoretical deduction, the eddy viscosity μ is proportional to the four-thirds power of the linear dimensions of the smallest details considered, so that we may write: $\mu(L) = mL^{4/3}$, where L is the wave-length. Now let E_L be the energy (per unit area) of a plane *monochromatic* wave component of length L. When examining a swell, which is at any fixed place supposed to be quasi-stationary (because of continuous supply of wave energy from the generating area), we have for the rate of variation of E_L with the distance of decay x on account of viscosity:

$$\frac{C}{2}\frac{dE_L}{dx} = -\frac{16\pi^2\mu E_L}{\rho L^2} = -\frac{16\pi^2 m E_L}{\rho L^{2/3}},$$

where C is phase velocity, ρ is density. Since, in deep water, $C^2 = Lg/2\pi$, we have:

$$E_L = E_L(0) \exp - \alpha x/L^{7/6}, \qquad (1)$$

where $\alpha = 8(2\pi)^{5/2}\, m\rho^{-1}g^{-1/2}$.



We shall use $L^{7/6} = \lambda$ as the independent variable and describe a continuous wave spectrum by means of an energy function $E(\lambda,x)$, such that $E(\lambda,x)d\lambda$ is the wave-energy contained in the part of the spectrum from λ to $\lambda + d\lambda$. Now $E(\lambda,0)$ will, as a function of λ, have a form of the general type shown in the accompanying diagram. Accordingly, we tried, as an analytical representation of the initial spectrum, the following form:

$$E(\lambda,0) = A\lambda^{-a} \exp - b\lambda^{-1},$$

where a and b are as yet unknown positive constants. From (1) it follows that

$$E(\lambda,x) = A\lambda^{-a} \exp - (b + \alpha x)\lambda^{-1}. \qquad (2)$$

The maximum of $E(\lambda,x)$ is found for $\lambda = a^{-1}(b+\alpha x) = \lambda_m$, which we might take to be the dominant or *significant* value of λ. Hence:

$$\lambda_m(x)/\lambda_m(0) = 1 + \alpha x/b. \qquad (3)$$

The total energy is found by integration to be

$$E_{\text{total}} = E_0(1 + \alpha x/b)^{1-a},$$

provided that $a > 1$. If we now take this energy to be proportional to the square of the *significant* wave-height H, we have apparently

$$H(x)/H(0) = (1 + \alpha x/b)^{(1-a)/2}. \qquad (4)$$

It is found that (3) and (4) are in accordance with the semi-empirical relationships found by Sverdrup and Munk[2] if we take $a = 3{\cdot}26$, whereas b, which has the dimension of λ, depends on the initial significant wave-length, that is, the wave-length at the end of the fetch. The value of α which fits most of the observations is $\alpha = 0{\cdot}85 \times 10^{-3}$ (metre)$^{1/6}$, so that m is found to be: $m = 3{\cdot}5 \times 10^{-3}$ kgm.m.$^{-7/3}$ sec.$^{-1}$. This yields for a wave-length of 100 m. a value $\mu = 1{\cdot}6$ kgm. m.$^{-1}$ sec.$^{-1}$ = 16 gm. cm.$^{-1}$ sec.$^{-1}$. Since, according to the theory of wind-driven ocean currents, any wind of 2·5 m./sec. would already be sufficient to maintain such a value of the eddy viscosity, our result seems very reasonable.

The assumption, which has been used in the above deduction, of a stationary state is, of course, an over-simplification. Especially if the duration of the wind in the generating area is not so very long (although long enough to reach a quasi-stationary state within the fetch), a stationary state of the swell in remote places will not be reached, because the long waves will already have died out there before the short ones arrive. Thus, in those cases the energy of the swell will, for sufficiently large values of x, be smaller than in the quasi-stationary case, so that even *smaller* values of the eddy viscosity will account for the observed decay.

But how about the air resistance? Sverdrup and Munk[2] ascribed all the energy-loss of swell to air resistance, and their computations based on this assumption seem to support it. There is, however, one more assumption that is essential for those computations, namely, that the value of the so-called 'sheltering coefficient'[6] or 'stream-lining coefficient'[2], which is a measure of the pressure-asymmetry along the wave profile, is the same for swell as for wind waves. This is, however, rather improbable. Indeed, it makes a great difference whether (as in the case of swell in calm air) the air moves only with respect to the wave profile and (practically) not with respect to the water; or, whether it moves also with respect to the water. Since in the first case the resistance due to friction between the air and the water is very much smaller than in the latter case, the pressure-resistance will also be much smaller, especially if we have to do with a long swell of small steepness. It may easily be seen that *without* friction and viscosity there would even be no pressure-resistance at all. Computation of the pressure-resistance of swell is very difficult; but it may be anticipated that it is, in general, of the same order of magnitude as the resistance due to the (small) friction between the air and the water.

Although we are aware of the fact that our presentation of a computation of swell characteristics on the basis of eddy viscosity considerations is, in more than one respect, very much over-simplified, our conclusion is that eddy viscosity is the principal factor determining the decay and effective period increase of ocean swell.

The lengthening of wind waves forms a different problem; but it seems probable that here also a selective loss of energy due to turbulence acts in favour of the longer waves.

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Spacings of Retained Austenite in Quenched White Cast Iron

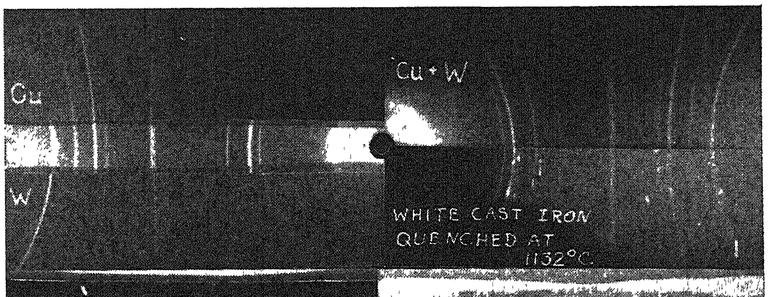
Little data has, as yet, been published concerning the spacings of retained austenite in iron–carbon alloys when the quenched sample contains the quantity of carbon ascribed to the saturation point E (1·776 per cent carbon at 1,145° C.) shown in the iron–carbon diagram. The only data as yet found refer to samples of plain carbon steel (1 mm. in diameter) containing 1·74 per cent of carbon and quenched at 1,130° C., for which the authors[1] give $a = 3{\cdot}613$ and $3{\cdot}624$ A. The first of the samples, according to the authors, was decarburized.

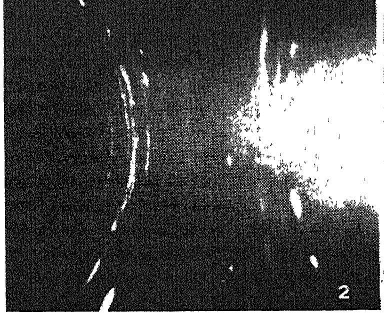
The difficulty in preventing loss of carbon when heating thin rods of high-carbon steel is obvious. Consequently, to provide a comparison between the estimated parameters of retained austenite in samples of high-carbon steel with those of samples that have, after heating, retained sufficient quantity of carbon, a white cast iron was chosen in which the total amount of alloying elements (manganese, silicon, phosphorus and sulphur) was less than 1 per cent, that is, similar in quality and quantity to those in mild plain carbon steels. Samples in the form of flat lumps (a few grams in weight) were quenched from a series of $A_{\text{cementite}}$ temperatures. The samples were then polished and examined both microscopically and by X-rays (low-angle glancing reflexion method, cobalt $K\alpha$ radiation). In certain cases the X-ray photogram was repeated and a pure tungsten powder was imposed on the surface for checking the positions of the lines of retained austenite.

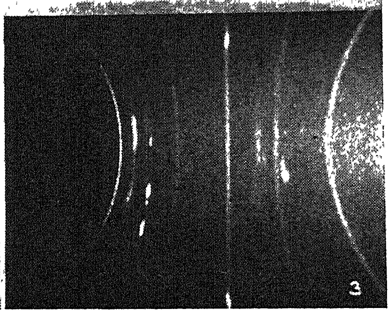
For control of the position of the 220 line of austenite, the 211 line of tungsten ($\theta = 43° 52'$) was used. An additional X-ray photogram was taken with pure powders of tungsten and copper, mixed together with tragacanth to give control by the combined substance method[2]. The position of the 220 line of copper ($\theta = 44° 26'$) corresponds to $a = 3{\cdot}61$ A.

The use of this method is demonstrated in Fig. 1. It shows a white cast iron quenched at 1,132° C. in brine. The right-hand bottom part of Fig. 1 shows the sample under examination; the right-hand upper part is for the mixture of copper and tungsten powders, while the left-hand part shows the pure copper and pure tungsten photograms imposed on the copper and tungsten mixture X-ray photogram for the identification of the lines. The positions of the 220 line of copper ($a = 3{\cdot}61$ A.) and that of the retained austenite line ($a = 3{\cdot}62$ A.) are easily compared, the latter equalling in parameter that given by Honda and Nishiyama[1] for plain carbon steel quenched from the same temperature (1,130° C.). The quantity of carbon dissolved in both cases, owing to the temperature of quenching[3], results in the same parameter of retained austenite. Consequently, the assumption that the character of retained austenite in both cases is the same appears to be justified.

One of the samples of white cast iron, when quenched from the semi-liquid state (about 1,180° C.), shows the retained austenite in the form of dots, owing to the large crystals produced during melting (Fig. 2); only two dots represent the 220 line. The X-ray photogram repeated with the tungsten powder deposit shows the 220 line of retained austenite also represented by two dots only (Fig. 3), which overlap with the 211 line of tungsten. The position of the line of retained austenite has moved to the position of the 211 line of tungsten ($\theta = 43° 52'$), giving the parameter of the retained austenite as $a = 3{\cdot}64$ A., that is, more than the value calculated from the formula given by me[3] ($a = 3{\cdot}6281$ for 1·776 per cent carbon). The micro-examination of the sample shows that the grains of retained austenite, owing to incipient fusion, have not only grown into large crystals but also are filled with needles of primary cementite. The dots indicating the 220 line of retained austenite are blurred, revealing the lattice distortion of retained austenite. As there is close linkage between the iron atoms in the interfaces between retained austenite and cementite, this distortion and the increase of parameter must be expected.







This investigation shows: (*a*) the highest spacing given, as yet, for retained austenite in iron–carbon alloys, (*b*) the usefulness of the combined-substance method for the estimation of spacings in the case of samples not suitable for powder-camera photograms. Further, it provides evidence that temperature is the factor deciding the character of retained austenite when sufficient carbon content is secured.

Detailed results connected with the heat treatment of white cast iron and other iron–carbon alloys and describing the nature of retained austenite will be published elsewhere.

I am indebted to Prof. C. W. Dannatt for the provision of facilities in this Department, and for discussion and help in carrying out the experiments.

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Utilization of Acetic and Propionic Acids in Sheep

THE level of volatile fatty acid in the peripheral blood of sheep is considerably higher than in non-ruminants, arterial levels reaching 10 mgm. per cent (as acetic acid) or greater, after feeding. The removal of volatile fatty acid from the arterial blood during its passage through the tissues of the head is considerable, and the extent of its removal is closely dependent upon its arterial level[1,2].

Preliminary chromatographic analyses by the method of Elsden[3] showed that acetic acid comprised 100 per cent and 94 per cent of the total volatile fatty acid in samples of arterial and venous blood respectively, and it was suggested that the arterio-venous difference for volatile fatty acid might be accounted for solely by the uptake of acetic acid by the tissues[1]. Recently, McClymont[4] observed arterial volatile fatty acid levels in five cows, after feeding and during fasting, of the same order as those previously reported by me for sheep. He found that acetic acid comprised more than 91 per cent (molar basis) of the volatile fatty acid in their arterial blood, and that small proportions of propionic, butyric and at least two higher acids were also present.

A total of nineteen analyses, by the chromatographic method of Moyle, Baldwin and Scarisbrick[5], have now been carried out on arterial and venous blood from seven sheep on five different rations. Arterial blood was obtained from the exteriorized carotid artery, and venous blood from the external jugular vein. All blood samples were collected four to eight hours after feeding, when fermentation in the rumen was at, or near, its daily maximum. Details of some of the analyses are given in the accompanying table, which includes the extremes of concentration obtained for each acid in arterial blood and, in addition, analyses of venous blood withdrawn at the same time[1,2].

The analyses show that, in sheep fed on rations of widely differing composition, 86–95 per cent (molar basis) of the total volatile fatty acid in arterial blood was acetic acid. Small amounts of propionic, butyric and at least one other acid were present in all samples. There was no evidence that acids, other than acetic, were removed from the blood in significant quantities during its passage through the head.

The efficient uptake of acetic acid by the tissues is compatible with the generally recognized ability of mammalian tissues to oxidize acetate completely. The small amounts of propionic acid in the general circulation indicate that this acid is removed from the portal system by the liver almost as rapidly as it is absorbed from the gastro-intestinal tract. Significant amounts of propionic acid would only appear in the peripheral circulation when the rate of absorption exceeded the maximum rate of its conversion to glucose in the liver. This would explain the comparatively high level of propionic acid found on one occasion in blood samples from sheep 132.

That propionic acid can be converted to glucose in the liver of the sheep has been indicated by Hitchcock and Phillipson[6] and by Jarrett[7], who observed that the administration of this acid to phloridzinized sheep resulted in the formation of equivalent amounts of glucose in the urine. The rapidity of this conversion was first indicated (Reid[1]) by the fact that the intravenous injection of sodium propionate solution relieved severe hypoglycæmic symptoms in an adrenalectomized ewe, following insulin injection, almost as rapidly as an equivalent dose of glucose, the blood-glucose showing an almost immediate rise to the normal level. Similarly, the injection of sodium propionate into two other sheep, with blood-glucose levels of 5 mgm. per cent, following insulin administration, produced an immediate rise in blood-glucose in each case.

A detailed account of this work, which was part of the research programme of the Division of Animal

VOLATILE FATTY ACIDS IN THE PERIPHERAL BLOOD OF SHEEP AFTER FEEDING

Sheep No	Ration (parts by weight)	Blood; arterial (A) or venous (V)	Volatile fatty acid concentration (× $10^{-5} M$)			% Acetic acid of total (vol. fat. acid)	Total (vol. fat. acid) (as mgm. acetic acid per 100 ml. blood)
			Acetic acid	Propionic acid	Butyric and higher acids		
J 118	Lucerne chaff 10 Wheaten chaff 30 Wheat 60	A	99	2	11	89	6·7
		V	78	2	6	91	4·7
J. 116	Lucerne chaff 25 Wheaten chaff 75	A	144	1	7	95	9·1
		V	98	1	6	93	6·3
132	Wheaten chaff 50 Wheat 44 Meat meal 5 Ground limestone 1	A	139	19	3	86	9·7
		V	103	20	4	81	7·6
132	do	A	211	8	9	92	13·7
		V	152	6	7	92	9·9
K.559	Lucerne chaff 10 Wheaten chaff 75 Bran 15	A	169	4	7	94	10·8
		V	124	4	7	92	8·1

Health and Production, Australian Commonwealth Scientific and Industrial Research Organisation, is being published elsewhere.

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Growth-Regulating Effect of Certain Organic Compounds

Since the discovery that β-indolylacetic acid and other organic compounds are active in regulating growth and development in the plant, much research has been directed toward the elucidation of the mechanism of regulation. This research has followed several lines, one being the attempt to correlate physiological activity with chemical structure[1–4]. It has been postulated that certain features of molecular structure and configuration are required for activity. Koepfli, Thimann and Went[1] suggest that these features are an unsaturated ring system and a side-chain carrying a carboxyl group at least one carbon atom removed from the ring. After an analysis of many compounds, Veldstra[2] re-orientates these requirements as a basal ring system with high surface activity and a carboxyl group in a very definite spatial position with respect to this ring system. The discussion has been carried further by Muir *et al.*[3], who postulate that, at least for the phenoxyacetic acids, "the position on the benzene ring adjacent to the point of attachment of the side-chain is directly involved in the growth reaction"; that is, if the compound is to have activity, at least one of the ortho positions needs to be free.

There are a number of methods by which activity can be measured. Before full use can be made of such measurements, it is necessary that technique should be standardized. The advantages of the straight-growth method, in which the growth of sections of *Avena* coleoptiles in test solutions is measured, have been concisely stated by Muir and his colleagues. It would seem, on theoretical grounds, that this method would be the most suitable to use for such studies. Further, it has been established by experimental work in this laboratory over the past two years that it can, in fact, be used as a quantitative method of assay. An analysis of experimental procedure for this method, and of variability in the data it provides, will be published shortly[5].

Using the straight-growth method, high physiological activity has been obtained with two compounds, 2,3,6-trichlorbenzaldehyde and 2,3,6-trichlorbenzoic acid. These substances do not fulfil the structural requirements of either Veldstra or Muir. The results are set out in the accompanying table. The figures are the means of tests carried out on four different occasions, using twelve coleoptile sections per solution on each occasion. Growth is expressed in terms of the growth of sections in β-indolylacetic acid at a concentration of 1 mgm./litre. This was used as a control on each occasion and is taken as 100 units.

Concentration (mgm /litre)	2,3,6-Trichlorbenzaldehyde	2,3,6-Trichlorbenzoic acid	2,4-Dichlorphenoxyacetic acid (own data)	2,4-Dichlorphenoxyacetic acid (data of Muir *et al*)
10·0	Inhibition	100	53	53
1·0	126	78	96	100
0·1	23	40	67	75

It is seen from the table that 2,3,6-trichlorbenzaldehyde is more active than β-indolylacetic acid at 1 mgm./litre; 2,3,6-trichlorbenzoic acid is less active than the aldehyde at the higher concentrations (at 10·0 mgm./litre it has not yet reached the inhibiting range). At 0·1 mgm./litre it is more active. Went[4] reports activity of other substituted benzoic acids as hemi-auxins in the pea test, but not as substances having growth activity. 2,4,6-, 2,4,5- and 3,4,5-trichlorbenzaldehydes have all been tested and have been shown to possess no activity.

It would appear, from these results, that a side-chain with a dipole at an angle to the ring, or a free ortho position in the ring, is not always necessary for activity.

Also included in the table are results for 2,4-dichlorphenoxyacetic acid, from tests carried out in April 1949. These confirm the report by Muir and his colleagues that this compound is effective in promoting cell-elongation. On the assumption that growth is proportional to the logarithm of the concentration, which is true in the straight-growth test, Muir's data have been converted into the same units as my own. Although there are a few points of variation in technique, the results from the two sources agree quite well. This confirms that it is possible with the straight-growth method to compare results between different workers—a necessary prerequisite to any interpretation of the data.

I am indebted to Imperial Chemical Industries, Ltd., Hexagon House, Manchester 9, for their co-operation, especially for supplying the chemicals.

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Some Morphological Features Accompanying the Aerobic Photodegradation of Whole Potato Starch

Peat and Whelan[1] have already described the chemical changes occurring during the aerobic photodegradation of amylose and amylopectin when dispersed in water. More recently, Whelan and Baker[2] have extended these investigations to commercial whole starches in the dry state (note: such starches still contain 15–20 per cent of bound water). During the aerobic degradation of whole starches, morphological changes were observed which promised to throw some light upon the gross and fine structural organisation of the raw starch granule. When potato starch irradiated in ultra-violet light of 3660 A. was mounted in a non-aqueous medium such as anisole (refractive index 1·51), microscopic examination showed that the majority of the granules still retained their birefringence. If examined at room temperature, in water, iodine solution or other aqueous reagents, the granules swelled almost immediately and lost their birefringence. These changes were accompanied by the separation of clearly defined surface membranes and by solubilization of the contents of the granule, which diffused slowly into the surrounding medium. Swelling appeared to be due in part to osmosis, since a proportion of the granules burst, leaving the peripheral membrane as a shrunken residue in which a clear rent, through which the solubilized contents had escaped, was always demonstrable. Also, on irrigation with ethanol, the process was reversed and the swollen granules contracted.

These and other features became more prominent when chloral hydrate was used as the swelling agent. On irrigation of chloral hydrate preparations with ethanol, the solubilized material was reprecipitated as an amorphous deposit within and, as a result of diffusion, around the granules. Moreover, where extraction of the solubilized material was complete, as well as a peripheral membrane, an entire series of interlamellar membranes could be observed in the interior of the granule. The membrane system showed no birefringence and gave no reaction with iodine in potassium iodide.

In attempting to assess the significance of these facts, the following points deserve attention. (1) Although separation was accompanied by osmotic swelling of the granule, the separated membranes were themselves unswollen. They bore no morphological resemblance to the swelling artefacts observed by Badenhuizen[3], Alsberg[4] and others, which were produced when potato and other starches were heated with water or swelling agents. (2) Whereas the partially or wholly solubilized contents of the granules gave a strong reaction with Schiff's reagent, no reaction could be observed in the membranes. Moreover, the membrane material was completely insoluble in strong sodium hydroxide solution at 100°. This insolubility, together with the negative Schiff's reaction, would appear to indicate that the aldehyde groups liberated on oxidation had undergone condensation, perhaps with adjacent polysaccharide chains, giving rise to a chemically inert and highly ramified structure. This interpretation would be in agreement with the fact that Haller[5] had previously demonstrated similar structures in potato starch granules treated with chemical oxidizing agents. (3) Since 99 per cent of whole potato starch can be accounted for as glucose residues, it seemed unlikely, though this possibility could not be definitely excluded, that the interlamellar material was not a carbohydrate. In that case the formation of resistant membranes by the interlamellar polysaccharide might be attributed to differences in kind or degree of supermolecular organisation rather than of chemical composition. The existence of such differences is, moreover, independently indicated by Frey-Wyssling's[6] demonstration of periodic variations in refractive index in the lamellæ of potato starch granules.

Furthermore, that the membrane system disclosed by photodegradation reflected a real difference in the intrinsic structural organisation of the intact granule was substantiated by the following additional facts: (4) When granules damaged by grinding in a ball mill for 48 hours at 50 r.p.m. were irradiated in ultra-violet light, osmotic swelling did not occur on contact with water and only damaged membrane residues were recovered. (5) Similar membrane structures could be demonstrated when starches baked at 200° C. were mounted in water or aqueous reagents, provided that swelling was retarded by dilution of the water or reagent with ethanol. Thus, the regional differences in rate of dextrinization disclosed by baking were essentially similar to the regional differences in rate of oxidation disclosed by photodegradation. (6) When maize starch was irradiated, no membrane residues were found; nor did osmotic swelling of the granules in aqueous media occur. The observed structural features of photodegradation, therefore, were in some way dependent upon the botanical origin of the starch. It may be noted, in conclusion, that such interspecific differences may be of other than purely academic interest, since Baker, Nasr and Morrice[7] have shown that the supermolecular organisation of starch granules exerts a determinant influence on the site, agents and nutritional outcome of starch breakdown in the gastro-intestinal tract.

We wish to thank Mr. Godden, head of the Biochemistry Department at the Rowett Research Institute, for recalling our attention to the significance of the membrane problem for nutrition.

FRANK BAKER

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W. J. WHELAN

Chemistry Department,
University College of North Wales,
Bangor.

Nov. 15.

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Mepacrine Hydrochloride in the Treatment of Avian Coccidiosis

IN a previous communication[1], two experiments were described in which mepacrine hydrochloride appeared to have a beneficial effect in the treatment of acute cæcal coccidiosis of chicks. In two treated groups, each comprising forty chicks, the death-rate was seven compared with twenty-six and twenty-three respectively in control pens of the same number, and it was suggested that this drug might prove a most useful agent in combating avian coccidiosis.

Further experiments on the lines indicated in the note were carried out, but the earlier promise of the drug was not maintained, results being frankly disappointing even when the dose was increased to 2 gm. per gallon of drinking water. In the later experiments, however, treatment did not begin until 72 hr. after the oral administration of oocysts, and this may partially explain the discrepancy in the results. In every case an equal number of infected chicks received sulphamezathine sodium (2 ounces per gallon of drinking water), and the death-rate in these groups was invariably insignificant.

Although it has no practical bearing, it may be of interest to note that, in two groups of chicks given mepacrine hydrochloride (2 gm. per gallon) for three days and seven days respectively prior to dosing with oocysts and continued for five days afterwards, the death-rate was 64 per cent and 57 per cent respectively compared with 92 per cent in untreated infected chicks, suggesting that the drug does have some coccidiostatic properties. In a control pen dosed with oocysts on the same day and given sulphamezathine sodium in the usual strength 72 hr. later and continued for five days, the death-rate was only 4 per cent.

It is apparent, therefore, that mepacrine hydrochloride compares very unfavourably with sulphamezathine sodium, and its use in the treatment of acute cæcal coccidiosis of chicks cannot be recommended.

J. E. Wilson
Ministry of Agriculture and Fisheries,
Poultry Laboratory,
Eskgrove,
Lasswade, Midlothian.
Oct. 29.

[1] Wilson, J. E., *Nature*, **163**, 250 (1949).

Experiments with 'Gammexane' in the Control of Lice on Poultry and their Bearing on the Problem of Vitamin D Intake

Recently, I conducted a series of experiments to determine the tainting effect of 'Gammexane' (benzene hexachloride) when used for the control of body lice on poultry. A commercial louse powder containing 5 per cent benzene hexachloride (15 per cent gamma isomer) was used. Dusted on the birds, this gave rapid and prolonged control of louse infestation, and when eggs from these birds were submitted to a panel of tasters they could detect no difference from eggs laid by control hens. Similarly, no taint could be detected in the meat when dusted birds were cooked and eaten. In the most severe test, birds were excessively dusted four times at weekly intervals and killed one week after the final dusting.

As a simpler method of louse control, the powder was sprinkled on the perches before the birds went to roost. The effect was not so lasting, but was easily repeated when necessary. The fumes of benzene hexachloride caused no tainting.

The third method tried was to sprinkle the powder heavily on the floor litter, the parasites being killed during dust-bathing. When grain is fed in this litter, a certain amount of benzene hexachloride is ingested ; and a high proportion of taints were found in the eggs and the flesh, the proportion of tainted eggs being highest about eight weeks after the application. There were also indications that hatching and fertility were impaired.

I consider that if used with care, so that no food is contaminated, 'Gammexane' is a more certain and a cheaper way of controlling body lice than the standard New Zealand method of using nicotine sulphate.

Quite apart from these conclusions, the results are extremely interesting in view of G. H. Bourne's communication[1] on the antirachitic value of sun-bathing in animals. Bourne directed attention to the work of Hou[2,3], who considered that birds obtained vitamin D through the irradiation of the preen oil spread over the feathers. Hou[4] showed that the skin and feathers are antirachitic, and suggested that, while preening, the bird took some of the irradiated oil into its mouth. In a later paper[5], however, he makes it clear that the irradiated oil is not the only source of vitamin D, or even the major source, as Bourne seems to suggest ; since he found irradiation of the legs and feet to be the most rapid way of curing rickets.

In view of the marked taint caused in eggs and flesh by the intake of a small amount of benzene hexachloride when feeding from contaminated litter, and the absence of taint when birds were dusted with a benzene hexachloride powder, it appears that virtually none of this substance was ingested by the latter group while preening. It does not seem, therefore, that poultry ingest an appreciable amount of preen oil since, in the dusted birds, this would be liberally mixed with 'Gammexane'. I would therefore suggest that the vitamin D formed in the oil by irradiation is not taken into the mouth, but is absorbed through the skin or down the feather shaft. Hou[1] has demonstrated the presence of oil droplets within the feather.

Since Hou and Tso[6] showed that human sebum is antirachitic, a similar method of vitamin D absorption may occur in mammals, where the sebaceous gland ducts form a known path[7] for the entry of fat-soluble substances.

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Oct. 25.

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[2] Hou, H. C., *Chin. J. Physiol.*, **4**, 79 (1930).
[3] Hou, H. C., *Chin. J. Physiol.*, **4**, 345 (1930).
[4] Hou, H. C., *Chin. J. Physiol.*, **2**, 345 (1928).
[5] Hou, H. C., *Chin. J. Physiol.*, **5**, 11 (1931).
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[7] White, R. Prosser, "Occupational Affections of the Skin", 25 (Lewis, London, 1928)

Effects of Penicillin and Streptomycin on Vaccine Lymph (Calf Lymph)

Heavy bacterial contamination of vaccine lymph (calf lymph), sometimes as high as 500 millions per ml., is inevitable during manufacture. The contaminants, in the tropics, though consisting mostly of staphylococci, may include a few *B. subtilis*, *B. coli*, *Streptococcus*, fungus, etc. None of the methods now used for their elimination is completely satisfactory. I have made a detailed study of the effects of penicillin and streptomycin on vaccine lymph under different conditions.

Penicillin is ineffective[1,2], contrary to the views held by certain workers[3,4,5], in reducing the bacterial contaminants of glycerinated vaccine lymph. This ineffectiveness is masked until and unless the sterility tests are made after complete removal of the residual penicillin from the penicillin-treated lymphs; for the bacteria in glycerine vaccine lymph are in a 'resting phase' in a non-nutrient medium; and penicillin is not bactericidal but only bacteriostatic under such conditions, as shown by Chain and Duthie[6].

Streptomycin, on the other hand, in a concentration of 5 mgm. per ml., reduces the bacterial flora of the glycerinated lymph, excepting the spore-bearers. In one experiment, the staphylococcal population of about 252 millions per ml. of vaccine lymph was reduced to a mere 240 per ml. within 24 hours contact with streptomycin in cold storage and to 40 per ml. after a further week. This finding is in conformity with the results of Strauss[7] and Garrod[8], who found that streptomycin is bactericidal both in nutrient and non-nutrient fluids, but in rather high concentrations in the latter. Acting synergistically with penicillin, as little as 500 μgm. of streptomycin with 500 units of penicillin per ml. of lymph is equally effective.

Streptomycin, both singly and in combination with penicillin, added to vaccine pulp immediately after its collection from the calf (but without addition of glycerol) and incubated at 37° C. for 24 hours, evoking a growth-phase of organisms, effectively reduces the bacterial flora of the vaccine lymph. *B. subtilis* spores do not remain unaffected. Under the same conditions, penicillin, by itself, in a concentration of 500 units per ml., acts on susceptible groups of bacterial contaminants but allows an abundant growth of *B. coli* organisms commonly present in the vaccine lymph.

Mere external application of 1,000 units of penicillin and 5,000 μgm. of streptomycin per ml. in sterile 50 per cent glycerine over the vaccinated area of the calf twice a day for five days reduces the bacterial contamination substantially. In this series of experiments, the bacterial content was only 200 per ml. of vaccine lymph from the treated animal, compared to 400 millions per ml. for the untreated control animal.

Parenteral administration of 40,000 μgm./kgm. weight streptomycin in combination with 8,000 units of penicillin/kgm. weight to a vaccinated animal in four divided doses daily, along with external application of streptomycin over the vaccinated area twice daily for five days, reduces the bacterial contamination much nearer to sterility than other methods. Repeated sterility tests revealed entire absence of bacteria; a colony of fungus was occasionally seen.

As against other methods, streptomycin and penicillin do not affect the potency of vaccine lymph under these conditions, and thus allow the use of highly diluted vaccines.

A practical application of these findings is that it permits the preparation of a purer calf lymph at a substantially lower cost than at present.

V. N. KRISHNAMURTHY

Government Vaccine Institute,
Bangalore.
Nov. 14.

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[3] Diaz Romero, *Arch. Soc. Biol. Montevideo*, **12**, 152 (1945); *Abs. J. Amer. Med. Assoc.*, **131**, 1100 (1946).
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Transport of Insects on the Exterior of Aircraft

THE carriage of insect eggs on the external surfaces of aircraft, as described by Senior, White and Kirkpatrick[1], is obviously of great potential importance to those concerned with quarantine against insect pests of agriculture and forestry. It is important that similar observations should be recorded so that it can be judged whether this means of distribution is rare and accidental or significantly constant in occurrence.

My own observations also relate to lepidopterous eggs, and it seems likely that insects of this order may furnish most of the examples of this means of distribution.

En route from Raratonga to Samoa on August 11, 1949, the N.Z. *N.A.C.* plane *Piere* stopped at Aitutaki, where Commander Malcolm directed my attention to what appeared to be insect eggs deposited on the fibrous tips of the static release cords on the tail plane. The eggs were unfortunately not kept for study. The plane spent the night of August 11 in the open on Faleolo airport, Upolu Isles, Western Samoa, and departed next day for Tonga. During the flight, Commander Malcolm came back to me with the drift recorder which projects under the plane. Two masses of eggs each about ½ in. long by ¼ in. wide had been deposited on the drift recorder, one on the mirror and one on the housing. If the drift recorder was in use the previous day, as is almost certain, any eggs then present on the mirror would have been noticed. It is therefore highly probable that the eggs were laid while the plane was at Faleolo. The eggs, on subsequent examination, were found to be sub-spherical and with a sculptured chorion and covered or mixed with fine linear scales or hairs. They were definitely lepidopterous, but I am unable to suggest the family to which they belong. First instar lepidopterous larvæ hatched from some of these eggs in the laboratory.

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[1] *Nature*, **164**, 60 (1949).

Projection of the Olfactory Epithelium on to the Olfactory Bulb: a Correction

IN a study of the peripheral pattern of olfactory innervation[1], observations were made on the rate of retrograde degeneration of olfactory receptors following lesions of the olfactory bulb. It was incidentally noted that, at least over the cartilaginous part of the septum examined, partial ablation of the bulb appeared to lead to a general thinning out of the receptors rather than to a localized area of complete atrophy. It was therefore inferred that, if the septal mucosa can be assumed to be representative of the olfactory mucosa as a whole, olfactory nerve fibres from each local area are distributed to all parts of the bulb. Afterwards, Adrian adduced good evidence, based on electro-physiological methods, that there is at least some degree of localization in the bulb, and indicated that this may have an important reference to problems of olfactory discrimination[2]. It was therefore deemed necessary to re-investigate the matter anatomically on a much more extended scale.

In a series of ten rabbits, varying proportions of the olfactory bulb were removed and, several weeks later, the animals were killed and complete serial sections prepared through the whole of the olfactory cavity in order to determine the regional distribution of retrograde degeneration in the olfactory epithelium. A preliminary study of these sections now makes it clear that there is certainly some degree of regional projection of the olfactory epithelium on to the bulb in the rabbit, and that the inference made on the basis of the earlier material of Clark and Warwick was premature.

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University Museum,
Oxford.

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[1] Clark, W. E. Le Gros, and Warwick, R. T. T., *J. Neur. Neurosurg. and Psych.*, **9**, 101 (1948).

[2] Adrian, E. D., "Sensory Integration" (University Press of Liverpool, 1949).

Stability of some Metal Complexes of Histidine

In the course of measuring the stability constants of internal complexes formed by the combination of a number of different bivalent metal ions with a series of α-amino-acids, including histidine, it was noticed that the last-named substance formed complexes that were much more stable than those of any other amino-acid studied.

The overall stability constant (K) for some of the different metal α-amino-acid complexes in water at 25° C. was determined by measuring the individual step reaction equilibrium constants:

$$Me^{++} + A^- \overset{k_1}{\rightleftharpoons} Me^+A$$
$$Me^+A + A^- \overset{k_2}{\rightleftharpoons} MeA_2,$$

where Me^{++} is the bivalent metal ion and A^- is the ligand (α-amino-acid). The overall stability constant of the complex MeA_2 is given by the relation $K = k_1.k_2$. Some values obtained for log K are shown in the accompanying table.

	Histidine	Glycine	α-Alanine	Valine	Leucine
Cu	18·33	15·42	14·83	14·45	14·34
Co	13·86	8·94	8·78	8·24	8·26
Zn	12·88	9·72	9·50	9·10	8·93
Mn	7·74	6·63	6·05	5·56	5·45

In the table, the order of the metals as regards the stability of their complexes is similar to that already noted with other ligands[1-4]. The interchange of the positions of the metals zinc and cobalt with some ligands has been noted previously[5].

If the complexes of any one metal are considered, it will be seen that the stability constants of the complexes formed with the α-amino-acids glycine, alanine, valine and leucine are of much the same order; the stability of the histidine complex, however, is much greater than any of these. This suggests that histidine is attached to a metal atom by groups different from those involved in the co-ordination of the other amino-acids. The latter are attached through carboxyl and amino-groups[6], the former probably through amino- and imino-groups[7].

In a study of the inhibiting effect of cobalt on various aerobic and anaerobic organisms and tumours, Burk and his collaborators[8] observed that, of a number of amino-acids tested, histidine and two of its derivatives were able to nullify the inhibiting effect of the metal. The data reported in the table provide, to some extent, a quantitative basis for the explanation offered by these authors[8] for the mechanism of the nullifying action of histidine. The two series of amino-acids studied were not identical, and further information on the stability constants of metal-amino-acid and other complexes is required before inhibiting actions like the above can be understood in detail. It is evident, however, that similar compounds which are capable of forming complexes of the same order of stability as those of histidine should be equally effective in overcoming the inhibiting effect of metal ions.

A fuller account of this work will shortly be published in the *Australian Journal of Scientific Research.*

L. E. Maley
D. P. Mellor

Department of Chemistry,
University of Sydney.
Oct. 18.

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[1] Mellor, D. P., and Maley, L. E., *Nature*, **161**, 436 (1948).

[2] Irving, H., and Williams, R. J., *Nature*, **162**, 746 (1948).

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Additive Effects of Substituents

The present practice of analysing data relating to reaction-rates in solution in terms of the parameters of the modified Arrhenius equation,

$$k = PZ \exp - E/RT,$$

has led to a more complete understanding of the way in which polar substituents affect chemical reactivity by focusing attention on the fact that the differences in rate may arise through changes in the energy of activation or in the entropy of activation (non-exponential term) or in both. Among the several reactions investigated, a number have been found in which the differences in rate can be accounted for almost entirely by changes in the energy of activation, variations in PZ in comparison being almost negligible.

Three such reactions are (I) the nuclear chlorination of phenolic ethers[1], (II) the benzoylation of anilines[2], and (III) the alkaline hydrolysis of ethyl benzoates[3]. Hitherto, in both the benzoylation of anilines and the hydrolysis of ethyl benzoates, investigations have been confined to the study of the influence of a single substituent in the benzene nucleus. Only in the first reaction, the chlorination of phenolic ethers, were the influences of two or more substituents determined. The rates of reaction of some two hundred ethers have been examined, and the important conclusion was reached that in ethers of the types p-RO.$C_6H_4.X$ and RO.$C_6H_3.X_2$ the effects of the groups R and X are additive.

The recent publication[4] of the results of a study of the rates of benzoylation of twenty-one disubstituted anilines in which it was found that "the resultant effect on the activation energy of two substituents in the same benzene nucleus is very closely the sum of their individual effects" is important, since it provides new and valuable evidence for the additive effect of substituents.

Evidence for a similar additivity is now available for the third of the three reactions, the alkaline hydrolysis of ethyl benzoates. Some twenty-five disubstituted esters have been examined, and the agreement between the values of the energy of activation obtained from the values of log k and those predicted on the assumption of a strictly additive relationship shows the same degree of correspondence as that obtained in the benzoylation of disubstituted anilines.

A full account of this investigation will be published elsewhere.

Brynmor Jones
J. Robinson

University College,
Hull.
Oct. 31.

[1] Jones, Brynmor, *J. Chem. Soc.*, 418, 676 (1942); cf. also *J. Chem. Soc.*, 1006 (1928), 1831 *et seq.* (1935).

[2] Williams and Hinshelwood, *J. Chem. Soc.*, 1079 (1934).

[3] Ingold and Nathan, *J. Chem. Soc.*, 222 (1936). Evans, Gordon and Watson, *J. Chem Soc.*, 1430 (1937).

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Geological Age of Meteorites

In a recently published survey of radiochemical and astronomical results on the age of the universe, the late Prof. R. C. Tolman[1] referred to the "surprisingly wide range of values" found by us[2] for the dates of solidification of meteoritic material. To other competent reviewers this range has appeared equally "perplexing"[3]; but even under the assumption that all meteorites are fragments of one planet, which, after its disintegration, have never been modified by a close approach to the sun, there seems to be no valid reason for the expectation that the ages of all of them should be of the same order.

While it is generally known that the rocks of the earth's surface belong to very different geological periods, there always was, and still is, a tendency among scientific men to picture the formation of the three main layers (core, mantle and crust) of any terrestrial planet as the result of a simple physicochemical separation, completed in one process at a fairly early stage of its development, under conditions of thermodynamic equilibrium[4]; but the study of many meteorites shows clearly that they have undergone repeated disruption and conglomeration and alternate heating and cooling. The mechanism and duration of these processes are still unknown, but they must have delayed the final solidification of some meteorites.

We are at present engaged in an extension of our meteorite studies. The new results may alter somewhat the earlier figures; but it seems improbable that they will indicate anything like a uniform age of all meteorites. There are no fossils in meteorites to guide us; but we believe that the wide range of ages found by the helium method for meteorites is the first indication of different geological periods in the history of their parent planet.

F. A. Paneth

Londonderry Laboratory for Radiochemistry,
University of Durham.
Jan. 9.

[1] Tolman, R. C., *Rev. Mod. Phys.*, **21**, 374 (1949).

[2] Arrol, W. J., Jacobi, R. B., and Paneth, F. A., *Nature*, **149**, 235 (1942).

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An Alternative to Latin Diagnoses

The International Rules of Botanical Nomenclature call for the diagnoses of new species and other groupings of plants to be given in Latin. In so far as the algæ are concerned this is to be regretted. From Latin diagnoses it is often impossible to obtain a clear description of the alga concerned or to distinguish it from one or more closely allied species. This is in part due to the impossibility of rendering, in Latin, the finer shades of meaning that can, for example, be expressed in French, German or English.

In Great Britain, at least, there are few men of science with a deep knowledge of Latin. Commonly, assistance has to be obtained in making Latin diagnoses or, what is worse, someone other than the author translates them. The translator may well neither be an algologist nor even a botanist. Even those proficient in Latin say it is not always possible to make an accurate rendering of all the terms used, nor can their readiness to assist be imposed upon too frequently.

It is said that, if diagnoses in other scientifically international languages are permitted, some biologists will take objection to and fail to use the languages chosen. This is, however, scarcely different from the present position when many hundreds of species of freshwater algæ are not diagnosed in Latin. Officially none is valid; but is anyone going to suggest that re-diagnosis in Latin will be other than a waste of time and paper? We even reach the absurd position where authors give shortened diagnoses in Latin "to comply with the International Rules". If my suggestion were adopted, every algologist would be able to render one of the two diagnoses called for in his own language. Zoologists have long given up Latin diagnoses and have not found it necessary to return to them. Since many algæ are included in both the animal and plant kingdom it seems particularly appropriate that the rule should be altered for this group. It appears that taxonomists of the higher groups of plants are firmly wedded to Latin diagnoses; but it may be hoped that a special ruling can be made for algologists at the forthcoming International Congress in Sweden, and a proposal has been submitted with this end in view.

The suggestion is that the second language in which the diagnoses is given should be French, German or English. Every taxonomist must be able to read these three languages, in which, moreover, the finer shades of meaning can be adequately expressed. Above all, it should be compulsory to give an illustration and the pertinent dimensions.

The suggested rule is therefore as follows. The diagnoses of all algal varieties, species, genera or higher classificatory groupings shall be given in two languages, one of which shall be French, German or English. The diagnoses shall be accompanied by an adequate illustration or illustrations and by the pertinent dimensions.

I should be glad to have the opinions of botanists on this matter and any suggestions for a more suitable wording of the rule.

J. W. G. Lund

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Ambleside,
Westmorland.
Feb. 13.

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, March 20

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 6 p.m.—Dr. Colin J. Smithells "The Manufacture, Properties and Applications of Aluminium and its Alloys" (Cantor Lectures). (Further Lectures on March 27 and April 3.)

INSTITUTION OF ELECTRICAL ENGINEERS, READING DISTRICT (at the Great Western Hotel, Reading), at 7 p.m.—Dr. W. G. Radley. "Trends of Development in Line Communication".

INSTITUTION OF OFFICE MANAGERS, SHEFFIELD BRANCH (joint meeting with the NATIONAL INSTITUTE OF INDUSTRIAL PSYCHOLOGY, at the Royal Victoria Station Hotel, Sheffield), at 7 p.m.—Mr. J. M. Fraser: "Nerve Centres of Industry".

INSTITUTION OF THE RUBBER INDUSTRY, LIVERPOOL SECTION (at Common Hall, Hackins Hey, Liverpool), at 7 p.m.—Mr. F. Amon: "Carbon Black Manufacture in England".

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 8.15 p.m.—Mr. H. St. J. B. Philby: "The Transformation of Arabia".

Tuesday, March 21

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Sir Richard Winstedt: "Protohistoric Elements in Malaysian Culture".

EUGENICS SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mrs. Barbara Bosanquet: "The Quality of the Rural Population".*

SOCIETY OF CHEMICAL INDUSTRY, CHEMICAL ENGINEERING GROUP (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. H. W. Ashton and Mr. G. T. Meiklejohn: "Cost Estimating in Process Development".

INSTITUTION OF ELECTRICAL ENGINEERS, CAMBRIDGE RADIO GROUP (at the Technical College, Cambridge), at 6 p.m.—Mr. W. Allen: "The Acoustics of Studios and Auditoria".

ROYAL AERONAUTICAL SOCIETY (at 4 Hamilton Place, London, W.1), at 7 p.m.—Mr. A. D. Young: "Boundary Layer at High Speeds".

Wednesday, March 22

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Prof. John Read, F.R.S.: "Chemistry as an Instrument of Culture" (Pope Memorial Lecture).

PHYSICAL SOCIETY, COLOUR GROUP (at the Royal Photographic SOCIETY, 16 Prince's Gate, London, S.W.7), at 3.15 p.m.—Tenth Annual General Meeting; at 3.30 p.m.—Mr. H. O. Dickinson: "Some Aspects of the Dye Sensitizing of Photographic Emulsions".

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY, CHEMICAL SECTION (at the Portico Library, Mosley Street, Manchester), at 5.45 p.m.—Dr. P. V. Youle: "P. B. Shelley's Chemistry Box".

SOCIETY OF CHEMICAL INDUSTRY, NUTRITION PANEL OF THE FOOD GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.15 p.m.—"The Nation's Manufactured Foods, 4, Jams and some other Spreads as Food".

CHEMICAL SOCIETY, MANCHESTER SECTION (joint meeting with the ROYAL INSTITUTE OF CHEMISTRY and the SOCIETY OF CHEMICAL INDUSTRY, at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Dr. H. W. Thompson, F.R.S.: "Some Recent Applications of Infra-Red Spectroscopy".

ROYAL STATISTICAL SOCIETY, BIRMINGHAM GROUP OF THE INDUSTRIAL APPLICATIONS SECTION (in the Chamber of Commerce, 95 New Street, Birmingham), at 6.30 p.m.—Dr. D. G. Beech: "Graphs and Correlation".

INSTITUTION OF ELECTRICAL ENGINEERS, MERSEY AND NORTH WALES CENTRE (at the Philharmonic Hall, Hope Street, Liverpool), at 6.45 p.m.—Dr. R. A. Smith: "Radar" (Faraday Lecture). (To be repeated on Tuesday, April 18, at the Royal Technical College, Glasgow, at 7 p.m., on Thursday, April 20, at the Literary and Philosophical Society, Westgate Road, Newcastle-upon-Tyne, at 7 p.m., and on Tuesday, May 2, at the Wellington Hall, Belfast, at 7.30 p.m.)

BRITISH INSTITUTION OF RADIO ENGINEERS, WEST MIDLANDS SECTION (at the Wolverhampton and Staffordshire Technical College, Wulfruna Street, Wolverhampton), at 7 p.m.—Mr. A. A. Dewey: "Radio Interference with Broadcast Reception".

ROYAL INSTITUTE OF CHEMISTRY, DUBLIN AND DISTRICT SECTION (in the Department of Chemistry, University College, Dublin), at 7.45 p.m.—Dr. A. E. Werner: "The Scientific Examination of Pictures".

Thursday, March 23

CHEMICAL SOCIETY, LIVERPOOL SECTION (in the Chemistry Lecture Theatre, The University, Liverpool), at 4.30 p.m.—Prof. M. G. Evans, F.R.S.: "Photo-excited Electron-transfer Reactions".

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Mr. M. J. Kelly "The Bell Telephone Laboratories—an Example of an Institute of Organized Creative Technology".

LINNEAN SOCIETY OF LONDON (joint meeting with the SYSTEMATICS ASSOCIATION, at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Discussion on "Biometrics and Systematics" (to be opened by Dr. R. Melville, Prof. Duncan Leitch and Dr. C. B. Williams).

LONDON MATHEMATICAL SOCIETY (at University College, Gower Street, London, W.C.1), at 5 p.m.—Prof. B. Segre: "Bertini Forms and Hessian Matrices".

MINERALOGICAL SOCIETY (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

INSTITUTION OF ELECTRICAL ENGINEERS, NORTH MIDLAND CENTRE (at the Lighting Service Bureau, 24 Aire Street, Leeds), at 6 p.m.—Discussion on "The Teaching and Functions of Mathematics in Electrical Engineering Courses". (Education Discussion Circle Meeting.)

PLASTICS INSTITUTE, LONDON AND DISTRICT BRANCH (at the Waldorf Hotel, Aldwych, London, W.C.2), at 6.30 p.m.—Mr. J. H. Collins. "Protein Plastics".

ROYAL INSTITUTE OF CHEMISTRY, LONDON AND SOUTH-EASTERN COUNTIES SECTION (at the South-East Essex Technical College, Longbridge Road, Dagenham), at 7 p.m.—Dr. R. Slack: "The Chemistry of some Actinomycetic and Bacterial Antibiotics".

Thursday, March 23—Friday, March 24

NATIONAL ASSOCIATION FOR MENTAL HEALTH (at Seymour Hall, Seymour Place, London, W.1).—Conference on "Mental Health and the Family".

Friday, March 24

ASSOCIATION OF APPLIED BIOLOGISTS (in the Mining Lecture Theatre, Imperial College of Science and Technology, Prince Consort Road, London, S.W.7), at 11 a.m.—Scientific Papers.

BIOCHEMICAL SOCIETY (in the Department of Biochemistry, University College, Gower Street, London, W.C.1), at 11.30 a.m.—Annual General Meeting.

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Geophysical Discussion on "The Formation and Destruction of Beaches".

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Miss Anne G. Shaw. "The Full Application of Motion Study".

MANCHESTER STATISTICAL SOCIETY, INDUSTRIAL GROUP (at the Albert Hall, Peter Street, Manchester), at 6.45 p.m.—Mr. A. Howarth: "Measurement of Production".

SOCIETY FOR VISITING SCIENTISTS (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Discussion on "Computing Machines and Brains" (to be opened by Mr. T. Gold, Mr. D. A. Sholl and Mr. A. M. Turing).

Sunday, March 26

INTERNATIONAL HÆMOPHILIA SOCIETY (at the Society for Visiting Scientists, 5 Old Burlington Street, London, W.1), at 2.30 p.m.—Annual General Meeting.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER (graduate) to teach Physics to Final B.Sc. standard, and a LECTURER (graduate) to teach Mathematics to Final B.Sc. standard—The Principal, Technical College, Essex Road, Dartford (March 25).

SENIOR LECTURER IN BOTANY at the Brighton Technical College—The Education Officer, Education Office, 54 Old Steine, Brighton (March 25).

LECTURER IN PRODUCTION ENGINEERING—The Principal, Royal Aircraft Establishment Technical College, Farnborough, Hants (March 25).

ORGANIC CHEMIST IN THE TECHNICAL CHEMISTRY DEPARTMENT—The Secretary, Hannah Dairy Research Institute, Kirkhill, Ayr (March 27).

SCIENTIST, Grade III (with a good honours degree in chemistry, preferably with some experience of, or special interest in, investigational work on chemical analysis)—The National Coal Board, Establishments Branch (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/195 (March 27).

CHIEF ENGINEER in the Public Health Engineering Department, Government of Bihar—The High Commissioner for India, General Department, India House, Aldwych, London, W.C.2, quoting No. 476.A (March 31).

ENTOMOLOGIST in the Department of Agriculture and Lands, Southern Rhodesia—The High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (March 31).

CHAIR IN THE HUMANITIES, and the CHAIR OF METALLURGY, at the New South Wales University of Technology—The Agent-General for New South Wales, 56 Strand, London, W.C.2 (April 1).

HOOVER POSTGRADUATE STUDENTSHIP IN PHYSICS, CHEMISTRY, ENGINEERING, or an allied subject—The Academic Registrar, University of London, Senate House, London, W.C.1 (April 1).

EXPERIMENTAL OFFICERS at Aircraft Experimental Establishments in Southern England: (*a*) PHYSICIST or ELECTRICAL ENGINEER to plan flight tests and supervise installations of new aircraft radio and radar equipment, (*b*) PHYSICIST for flight testing of new aircraft navigation equipment, (*c*) ENGINEER (Mech. or Aero) to take charge of section studying problems of glider towing and aircraft snatch, (*d*) PHYSICIST or ENGINEER with general experience transport aircraft for work on loading, stressing, etc., of aircraft, (*e*) ENGINEER preferably with experience on flight test work for aircraft performance testing, (*f*) ENGINEER for work on airframe structures and general installation and engineering appraisal of aircraft, (*g*) PHYSICISTS or ENGINEERS (Mech. or Aero) with interest in aircraft and in flying for performance testing and flight test work in prototype aircraft and equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.32/50 for posts *a*, *b*, *d* and *g*, or C.87/50 for posts *c*, *e* and *f* (April 1).

EXPERIMENTAL OFFICERS (3, temporary) in the Mechanical Engineering Research Organisation (Department of Scientific and Technical Research) for (*a*) the application of electronic techniques to the measurement of transient forces and small movements (Ref. D.48/50A), (*b*) basic research on the machinability of metals (Ref. C.89/50A), and (*c*) the design and development of equipment and instruments for investigating the performance of and the flow conditions in models of pumping machinery, etc. (Ref. C.90/50A)—The Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (April 1).

TECHNICAL AUTHORS at Admiralty headquarters and in various Naval Establishments, to prepare official technical publications and handbooks on armament, mechanical and electrical apparatus, radio equipment and underwater weapons, including Asdic, used in H.M. ships—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting D.49/50A (April 1).

DEVELOPMENT OFFICER (Industrial Machinery), Government of India, to advise and assist in the improvement of industrial machinery manufactured in India—The High Commissioner for India, General Department, India House, Aldwych, London, W.C.2, quoting No. 479.A (April 3).

BACTERIOLOGIST (medical) in the Government Medical Laboratories, Western Australian State Public Service—The Official Secretary, Western Australian Government Office, Savoy House, 115–116 Strand, London, W.C.2 (April 6).

PHYSICAL CHEMISTS (Senior Scientific Officer grade) in the Ministry of Supply in London, for duties involving liaison with Service and Overseas Departments and development work concerned with application of plastics and rubbers to Service use—The Ministry of Supply and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.158/50A (April 8).

SCIENTIST, Grade III (with an honours degree in science, preferably in chemistry or physics, or an equivalent qualification) (Ref. TT/197), and a SCIENTIFIC TECHNOLOGIST, Grade II (with a H.S.C., preferably with physics and chemistry, or an equivalent qualification) (Ref. TT/198), in the Scientific Department of London headquarters—The National Coal Board, Establishments Branch (Personnel), Hobart House, Grosvenor Place, London. S.W.1, quoting the appropriate Ref. No. (April 10).

PROFESSOR OF APPLIED PHYSIOLOGY—The Secretary, Royal College of Surgeons, Lincoln's Inn Fields, London, W.C.2 (April 12).

RESEARCH WORKERS (should be qualified as chemical or electrical engineers, or have graduated with honours in physics or chemistry, or hold equivalent qualifications) to carry out investigations in carbonization, briquetting, coal preparation, electrical and mechanical engineering problems connected with the Coal Industry—The National Coal Board, Establishments Branch (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/200 (April 12).

STAFF TUTORSHIP IN PSYCHOLOGY—The Director, Department of Extra-Mural Studies, Senate House, London, W.C.1 (April 12).

LECTURER IN THE DEPARTMENT OF PSYCHOLOGY—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1 (April 14).

LECTURER OR ASSISTANT LECTURER IN THE FLUID MOTION LABORATORY—The Registrar, The University, Manchester 13 (April 14).

PHYSICISTS for (*a*) electrical and optical recording in connexion with underwater ballistic investigation, (*b*) with good knowledge mathematics for general experimental research, (*c*) with general experience and interests, including knowledge electronics, (*d*) with knowledge electronics and radar or strain gauge work, (*e*) for radiological research (industrial X-ray experience desirable), and PHYSICISTS OR ELECTRICAL ENGINEERS with (*a*) experience in design use and servicing of electronic instruments, (*b*) experience in use of electronic techniques (experimental ability essential), in Ministry of Supply Research and Development Establishment near London—The Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.29/50A (April 14).

ASSISTANT LECTURER IN MATHEMATICS—The Registrar, King's College, Strand, London, W.C.2 (April 15).

LECTURER IN INDUSTRIAL PSYCHOLOGY—The Registrar, The University, Leeds 2 (April 15).

RAMSAY MEMORIAL FELLOWSHIP FOR CHEMICAL RESEARCH—The Joint Honorary Secretaries, Ramsay Memorial Fellowships Trust, University College, Gower Street, London, W.C.1 (April 17).

LECTURER IN GEOGRAPHY with special reference to Regional and Economic Geography—The Secretary, London School of Economics and Political Science, Houghton Street, Aldwych, London, W.C.2 (April 18).

UNIVERSITY LECTURERS or UNIVERSITY DEMONSTRATORS in either THERMODYNAMICS or its applications, or in ELECTRICAL ENGINEERING —The Secretary, Appointments Committee, Engineering Laboratory, Cambridge (April 19).

LECTURER IN PHARMACOLOGY—The Secretary, University College, Gower Street, London, W.C.1 (April 20).

CHAIR OF ARCHÆOLOGY OF THE ANGLO-SAXON PERIOD at University College—The Academic Registrar, University of London, Senate House, London, W.C.1 (April 21).

LECTURER IN PHYSICS—The Registrar, King's College, Strand, London, W.C.2 (April 22).

LECTURER IN BIOCHEMISTRY, and an ASSISTANT LECTURER IN PHYSIOLOGY—The Registrar, University College, Cathays Park, Cardiff (April 30).

POSTGRADUATE STUDENTSHIPS at a British University or research institute for research in the Colonial Empire in (*a*) Soil Science, (*b*) Insecticides, Fungicides and Herbicides. (*c*) Stored Products Entomology. (*d*) Fisheries—The Under-Secretary of State, Colonial Office (Research Department), Sanctuary Buildings, Great Smith Street, London, S.W.1 (April 30).

ASSISTANT LECTURER IN THE DEPARTMENT OF APPLIED MATHEMATICS—The Registrar, The University, Liverpool (May 1).

NUFFIELD STUDENTSHIPS and FELLOWSHIPS for experimental and theoretical research in Nuclear Physics—The Professor of Natural Philosophy, The University, Glasgow, W.2 (May 1).

RESEARCH POSTS IN APPLIED ECONOMICS—The Secretary, Oxford University Institute of Statistics, 91 Banbury Road, Oxford (May 1).

ASSISTANT DIRECTOR in the Commonwealth Bureau of Pastures and Field Crops, Aberystwyth—The Secretary, Commonwealth Agricultural Bureaux, 2 Queen Anne's Gate Buildings, Dartmouth Street, London, S.W.1 (May 1).

LECTURER IN GEOGRAPHY—The Secretary, Queen's University, Belfast (May 1).

READERSHIP IN GEOLOGY at Birkbeck College—The Academic Registrar, University of London, Senate House, London, W.C.1 (May 2).

LECTURERS OR ASSISTANT LECTURERS (4) IN THE DEPARTMENT OF PHYSICS—The Registrar, The University, Manchester 13 (May 8).

SENIOR LECTURER IN MECHANICAL ENGINEERING at the National School of Engineering, Canterbury University College, Christchurch, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (May 8).

WELLCOME CHAIR OF CLINICAL TROPICAL MEDICINE at the London School of Hygiene and Tropical Medicine—The Academic Registrar, University of London, Senate House, London, W.C.1 (May 8).

BOTANISTS (2) to assist in the preparation of a Flora of Tropical East Africa, which is being undertaken by the Royal Botanic Gardens, Kew—The Under-Secretary of State, Colonial Office, Research Department, Sanctuary Buildings, Great Smith Street, London, S.W.1.

CHIEF CHEMIST for new cement factory in Uganda—The Uganda Electricity Board, 129 Grand Buildings, Trafalgar Square, London, W.C.2.

CLINICAL PATHOLOGIST and LECTURER of consultant status in the Medical School—The Secretary, Charing Cross Hospital Medical School, 62–65 Chandos Place, London, W.C.2.

DESIGN ENGINEERS to design very large factories, including special equipment and plant and the layout required for efficient manufacturing processes—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

ECONOMIC BOTANIST—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

ELECTRICAL ENGINEER in the Marine Department, Nigeria—The Director of Recruitment (Colonial Service), Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27326/32.

EXPERIMENTAL OFFICER (male) to render skilled technical assistance (including photography) to resident and visiting research workers, to supervise the work of laboratory attendants, to prepare marine animals and plants for research and sales purposes—The Director, Marine Station, Millport, Isle of Cumbrae.

FUEL TECHNOLOGIST to carry out applied research in the Iron and Steel Industry—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting 'Fuel Technology'.

RESEARCH WORKER to take part in a programme of research in Tissue Culture—The Secretary, University College, Gower Street, London, W.C.1.

SYSTEMATIC FOREST BOTANIST in the Forest Department, Sierra Leone, for silvicultural supervision and research, preparation of a forest herbarium, co-ordination of records of utilization and silviculture, and ecological studies of forest flora—The Director of Recruitment, Colonial Office, Sanctuary Buildings. Great Smith Street, London, S.W.1.

SCIENTISTS with chemical and/or botanical qualifications, for an investigation into the uptake of nuclear fission products by marine algæ—The Secretary, Scottish Seaweed Research Association, Inveresk Gate, Musselburgh, Midlothian.

SENIOR SCIENTIFIC OFFICERS and SCIENTIFIC OFFICERS in various Government Departments and for a wide range of scientific research and development in most of the major fields of fundamental and applied science—The Secretary, Civil Service Commission (Scientific Branch), 7th Floor, Trinidad House, Old Burlington Street, London, W.1, quoting No. 2887.

STATISTICIAN (preferably with an honours degree in mathematics with special knowledge of statistics and statistical methods) in the Research Division of the Ministry of Agriculture, Sudan—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Statistician'.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Selected Government Research Reports. Vol. 4: Textiles and their Testing. Pp. iv+86. (London: H.M. Stationery Office, 1949.) 6*s*. net. [1512

Bulletin of the British Museum (Natural History). Geology, Vol. 1, No. 1: The Pterobranch *Rhabdopleura* in the English Eocene. By Henry Dighton Thomas and Arthur George Davis; with an Appendix on the London Clay at Lower Swanwick, Hampshire, by Arthur Wrigley. Pp. 24+3 plates. 7*s*. 6*d*. Geology, Vol. 1, No. 2: A Reconsideration of the Galley Hill Skeleton. By K. P. Oakley and M. F. Ashley Montagu. Pp. 25–48+plate 4. 5*s*. (London: British Museum (Natural History), 1949.) [1512

Scientific Instrument Manufacturers' Association of Great Britain. List of Preferred Valves. Pp. 28. (London: Scientific Instrument Manufacturers' Association of Great Britain, 1949.) 2*s*. 6*d*. [1512

Other Countries

United States Department of the Interior: Geological Survey. Water-Supply Paper 1055: Surface Water Supply of the United States, 1946, Part 5, Hudson Bay and Upper Mississippi River Basin. Pp. xii+471. 1.25 dollars. Water-Supply Paper 1056: Surface Water Supply of the United States, 1946, Part 6, Missouri River Basin. Pp. xii+588. 1.50 dollars. Water-Supply Paper 1065: Surface Water Supply of Hawaii, 1945–46. Pp. vi+138. 40 cents. Water-Supply Paper 1074: Water Levels and Artesian Pressure in Observation Wells in the United States in 1946, Part 4, South-Central States. Pp. vi+215. 75 cents. (Washington, D.C.: Government Printing Office, 1949.) [1512

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HIGHER TECHNOLOGICAL AND UNIVERSITY EDUCATION

THE training of technologists and, more particularly, whether it should be given by the universities, by some modification of the existing colleges of technology, or by the creation of new institutes of technology of university status, has been under intermittent discussion ever since the Percy Committee reported in July 1945. In recent months the exchange of views has become much livelier. In November, Prof. M. L. Oliphant contributed an article, "University or Institute of Technology ?", to the *Universities Quarterly*. Shortly afterwards, a speech by Sir John Anderson at the Foundation Day celebrations of the University of London led to an exchange of correspondence in *The Times*. Meanwhile, methods of improving technological education in Britain were discussed at the annual conference of the universities of Great Britain and Northern Ireland; and the University Grants Committee published in January last "A Note on Technology in Universities"*. This was followed immediately by a series of articles in *The Times Educational Supplement*, to which Mr. M. W. Perrin, Lord Cherwell, Mr. Patrick Johnson, Principal H. Lowery and J. R. Killiam, president of the Massachusetts Institute of Technology, contributed. A commentary on "Higher Education for Technologists" by Prof. A. R. Ubbelohde appeared in the February issue of *Research*, while a report on "Future Developments in Higher Technological Education" was presented to a meeting of the Association of Technical Institutions on February 24 by Principal F. H. Reid. The matter was also discussed in the House of Lords on March 14.

Through all this debate, despite some decided clash of opinion, there is, as has already been noted in these columns (see, for example, *Nature*, January 28, p. 125), a fair measure of agreement. It is recognized that the technological courses required, as regards the intellectual discipline they demand, have the character of university courses. There is in consequence no suggestion that the degree or diploma obtained by those who complete the courses satisfactorily are in any way inferior to those obtained as a result of study in more academic fields at a university. The issue is, really, where and how such training can most effectively be given.

Prof. Oliphant frankly expressed the view that applied science, as at present taught and developed, is out of place in a university. No university, he said, can hope to possess equipment for teaching engineering, for example, which is adequate or remains up to date and in line with that used in industry. If applied sciences remain in any university, they must become studies in the engineering sciences—thorough training in modern mathematics, including the new methods in applied mathematics, modern physics in all its branches, recent advances in chemistry and other subjects cognate to the future of technology. The university would thus have to convert those courses which are making it a technical school into disciplines in accord with its real spirit and function.

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* University Grants Committee. A Note on Technology in Universities. Pp. 8. (London: H.M. Stationery Office, 1950.) 4*d.* net.

Prof. Oliphant thus holds that we should and must develop in Britain institutes of technology or universities of applied science, whatever we may call them, where applied science is taught. By attaching such institutions loosely to universities and locating them on or near the university sites we would avoid those administrative difficulties in applied science to which Prof. Ubbelohde in particular has directed attention, and would provide a healthy climate for the proper development of the special functions of both aspects of higher education and research. Similar ideas were expressed by Sir Lawrence Bragg at the Home Universities Conference in London in December, when he pointed out that few, if any, of the larger institutions teaching technical students have freedom to plan courses, decide rates of pay and conditions of work for teachers and assistants, the amount of attention to be given to different subjects and policy in regard to research, and standards for degrees or other awards. The absence of that freedom in technical education, he said, has kept the technical colleges in the character of poor relations.

Sir Lawrence Bragg suggested that the ideal would be to establish new centres of higher technical education which would decide their own standards and courses and would differ from new universities solely in outlook. Such centres should be staffed with men experienced in technology and successful in the world of action. Even so, Sir Lawrence considered that some branches of technological education should be represented in the universities which, as a matter of practical politics, are the only places in which higher technological education could flourish at present. Moreover, he believed that one end of the wide spectrum of technological education does find a fitting place in the university framework.

With this plea for accepting the present position and providing for the immediate expansion of technological teaching within the universities as the best means of meeting the immediate demand, Sir Lawrence coupled a plea for first-rate teaching by men who would command the respect of industrialists through their own achievements in the industrial field. Sir Edward Appleton, who also contributed to the discussion, dealt with the respective functions of the technical colleges and of the universities and, like Prof. Oliphant, insisted that, in technological training in the universities, fundamental training must tend to exclude technological detail if the purpose is to be achieved of turning out graduates who will find the later assimilation of the material of technological applications relatively easy. A similar comment was made by Sir Roderic Hill, rector of the Imperial College of Science and Technology, at the annual luncheon of the Parliamentary and Scientific Committee; he pointed out that if these great technological institutions should come into being, they would ultimately become universities. He said that the over-riding problem is to advance science and technology—which, rightly studied, form an intellectual discipline and contribute to a liberal outlook—and to raise the level of philosophical understanding so that they are wisely used. Our main hope, he believes, is the creation of an atmosphere in which human thought can flourish, and, in general, he thinks this would be best accomplished with the aid of universities with a large and representative range of faculties.

Not even Prof. Oliphant's forthright remarks provoked quite the discussion that followed Sir John Anderson's remark, in his speech at the University of London, that experience might show that much of the work which the universities are doing could be undertaken with greater advantage by other types of institution. Sir John was stressing the need for a great development of higher education in Britain, whether in universities, in colleges of technology or in other types of institution; he urged universities to watch these developments closely, and suggested that the extent to which, and the methods by which, universities align themselves to a common national policy call for close and continuous study. He thought the universities should realize that the maintenance of their freedom from departmental control, and with it their continued freedom to proceed untrammelled in the pursuit of knowledge, are likely to depend on their willingness to exert such guidance as would keep their contribution in the field of higher education in harmony with current conceptions of the national interest. Speaking afterwards to the Parliamentary and Scientific Committee, Sir John Anderson said that the whole subject is now in the hands of the National Advisory Council for Education in Commerce and Industry, and that the problem is to raise the status and prestige of technology without attempting to exclude universities or other institutions, which should not be inhibited from making such contributions as they may feel able to make.

It is against this background that we should consider the subsequent note from the University Grants Committee. This note expresses accord with the view that certain aspects of technology or applied science are well suited to university study; but suggests that the work of a university in technology should be much more closely related to fundamental science or other relevant studies than that of a technical college. Without implying any difference in status, the courses should be more widely based on higher standards of fundamental science, and contain a smaller element of training related to immediate or practical work in industry. Nevertheless, the distinction should be recognized more clearly in planning further changes.

It does not appear from this note that the University Grants Committee, or its joint committee with the National Advisory Council on Education for Industry and Commerce, has, however, yet been able to make up its mind whether it is worth while bringing the whole field of technology within a single group of institutions. Despite the undoubted advantage to the university of having technologists form part of the student body, and to industry of some technologists being educated in universities in contact with students drawn from a wide variety of faculties, it is recognized that in practice, especially at the present time, such advantages may well be illusory. This has been pointed out in the correspondence provoked by Sir John Anderson's address, and there are also legitimate doubts as to whether present arrangements do, in fact, favour the closest possible association of university teaching and research in technology with the fundamental sciences. Even if students of technology are trained in fundamental sciences in departments where a wide range of research is being actively pursued, such association by itself may not ensure that the standards of work and research in the science departments permeate the departments of applied science; nor is the contact of the staffs of the departments of pure science with those dealing with problems of an applied nature necessarily sufficient.

The University Grants Committee in its recent "Note" is content to state the principal issues involved in the general problem. The benefit to the student of applied science of some industrial experience at an early stage in his career, the importance of more university research in technology and the value of some such research in problems related to the interests of local industry, and the importance of extending postgraduate activities in the field of technology to include some postgraduate instruction as distinct from research, are all recognized. Nor is there any disposition to suggest that there is only one solution or method of approach; though inasmuch as the "Note" assumes that for the present no more than about 250 men a year of this type are required and that postgraduate courses of one or two years duration will meet the demand, the Committee may have taken too narrow a view of the situation.

The case for segregation has been most ably and forcefully argued by Prof. Ubbelohde, both on principle and on practical grounds. As he rightly says, even when academic studies are properly balanced, technological studies call for special treatment because of the different approach. Unless the treatment of such studies is right, and unless due care has been taken to base them on a liberal education in the schools and to keep them in balance throughout with the humanistic and social subjects —in some such way as Dr. Killiam describes as effected under the scheme drawn up so early as 1846 by Prof. Burton Rogers, out of whose concepts the Massachusetts Institute of Technology has evolved—little will be achieved by the mere intermingling of students of technology with other university students.

Prof. Ubbelohde's case for the creation of institutes of advanced technology, apart from the important argument that the administration of advanced teaching in technology differs in kind from that required in the administration of university affairs and budget, rests largely on the belief that this step would reconcile the arguments for and against the segregation of technological studies from academic studies. Even so, Prof. Ubbelohde suggests that a combination of this policy with the promotion of more extensive advanced work in selected technical teaching organisations already in existence would eventually prove the most fruitful in promoting postgraduate work of the highest quality. It will be noted also that this advanced technological work is, in either method, to be based on an academic education in which at least the methods of teaching have reflected the academic approach. This is essential if an institute of technology is to give really vigorous teaching in the methods of applying new knowledge, and to teach the experimental spirit in attempting new applications.

Here Prof. Ubbelohde stresses the importance of some co-operation with the activities of industrial firms, particularly if the cost of experimental facilities is not to be excessively heavy. He develops in some detail the idea that the research associations might play an important part, and his suggestion that a census of life-histories of the research staff, at least in the longer-established associations, should be taken deserves to be implemented. One object of such a census—to determine what proportion of the research workers in a research association might reasonably be expected to take up technological posts in industry at a later stage—would provide the answer to a question which the promised survey of the research association movement by the Department of Scientific and Industrial Research should undoubtedly ask. Such a census would also indicate how far the work of any research association could be linked up with advanced teaching of the technologies. Later it might also be possible for research associations to provide such postgraduate students with limited opportunities for postgraduate work. Quite apart from the need to review first the other principal teaching activities of an institute of technology, such a proposal must remain very tentative until the position of the research association movement as a whole and its contribution to industry have been objectively and authoritatively reviewed.

Prof. Ubbelohde's proposals appear to meet the need which Lord Cherwell has stressed in respect of modern engineering in arguing for technical universities, and to provide the cross-fertilization and liberal education which are essential in order to avoid producing narrow specialists. They should equally provide that grasp of affairs which Mr. Johnson notes as characteristic of the average graduate of a good Continental school of technology. It is implicit in Lord Cherwell's and Prof. Ubbelohde's argument that the graduates of any new institutes of technology should be able to write and argue consistently and clearly, to make their case forcibly to the enterprise they serve and to comprehend the social or the economic purport of their service. Nor is it probable, as both Mr. M. W. Perrin and Principal H. Lowery indicate, that the upgrading of some of the present technical colleges in Britain to full university status could contribute to anything like the same extent to this end. Quite apart from the fact that the existing technical colleges have an essential function to fill in the training of technicians, for which alone their resources require extending and expanding, the staffing, accommodation and equipment, as well as the administration, required for higher technological training go far beyond anything possible in their present structure without changes which would in effect transform them into new and independent institutions.

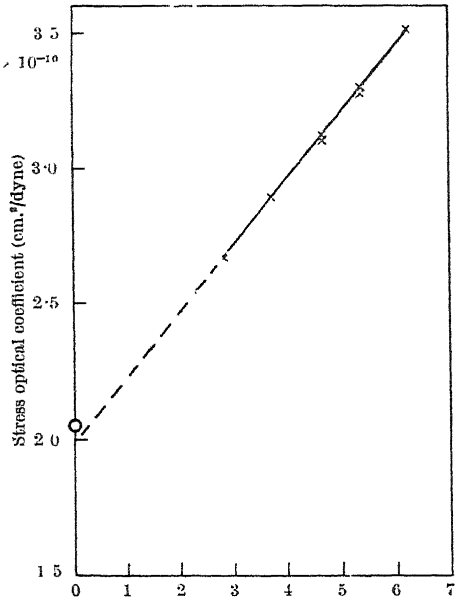
Birefringence in Rubbers

It has been shown, both theoretically[1] and experimentally[2,3], that in simple elongation of a sample of a pure gum vulcanizate, an approximately linear relationship between the tensile stress t and the birefringence $(n_1 - n_2)$ obtains, provided the strain is not sufficiently large to produce crystallization. We may write

$$(n_1 - n_2) = Ct, \qquad (1)$$

where C, the constant of proportionality, is termed the 'stress-optical coefficient', and is theoretically independent of the degree of cross-linking (vulcanization) of the vulcanizate and should be identical for all pure rubbers.

Thibodeau and McPherson[3] have shown that the stress-optical coefficient is dependent upon the type of vulcanization. In particular, for gum vulcanized by means of sulphur without accelerators but in the presence of stearic acid and zinc oxide, they found the stress-optical coefficient to depend linearly on the amount of combined sulphur. This dependence upon degree of vulcanization suggests that the sulphur is modifying either the polarizability or the stiffness of the molecular chains of the network. An extrapolation of the linear relation to zero combined-sulphur content has been used by Treloar as a measure of the birefringence of the actual molecular network



×—×—, Sulphur vulcanizate (Thibodeau and McPherson)
O, peroxide vulcanizate (Saunders)

Recently a vulcanized rubber has been produced which is free from all additions to the rubber; particularly it is free from sulphur. The vulcanization is achieved by a peroxide reaction[4], and all the by-products can be removed, leaving a pure hydrocarbon vulcanizate. It is interesting to determine the stress-optical coefficient for this material and compare it with the results obtained by Thibodeau and McPherson.

The birefringence of a thin strip of the peroxide vulcanizate elongated under a known load was measured using crossed Nicol prisms and a Babinet compensator. The relation between the stress and the birefringence was found to be linear and reversible up to strains of about 100 per cent, and the stress-optical coefficient was $2 \cdot 05 \times 10^{-10}$ cm.²/dyne. This compares very well with the value obtained by extrapolating the results of Thibodeau and McPherson to zero combined-sulphur content.

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Welwyn Garden City, Herts.
Oct. 28.

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[3] Thibodeau and McPherson. *Bur. Stand. J. Res.*, **13**, 887 (1934) *Rub. Chem. and Tech.*, **8**, 183 (1935).

[4] Farmer and Moore, unpublished work; but see Gee, *Trans Inst. Rub Indust.*, **25**, 88 (1949).

Elastico-Plastic Straining when the Principal Stresses Rotate

In recent years there has arisen a controversy, on theoretical grounds[1], on whether post-yield straining of metals should be analysed by considering: (I) plastic increment-strain components only (Levy, about 1870, and Mises later[2]); (II) plastic total-strain components only attained instantaneously (Nadai, 1931 [3]); (III) plastic + elastic increment-strain components (Prandtl, 1924, and Reuss, 1930 [4]); (IV) plastic + elastic total-strain components attained incrementally (Swainger, 1945 [5]). It is shown in this communication that, from experimental evidence, none of these theories is correct; but that a simple modification to my theory in (IV) leads to correct predictions; that is, one must consider (V) plastic increment-strain components + elastic total-strain components attained incrementally.

This step was not taken arbitrarily, but reached from the consideration that continuity of straining-displacement[6] must be assured for a body *as a whole*, and its instantaneous shape under elastico-plastic straining should be the reference for the next increment of deformation.

A searching test of a theory predicting post-yield strain values is given by rotating the principal normal-stress system relative to the substance at a given point in the body. Peters, Dow and Batdorf[7] undertook the test by loading with combined axial compression and torsion on two thin-walled duralumin cylinders. Each cylinder was made to yield by axial compression stress S_{xx}, and then complex rotating stresses were induced by applying axial torsion to induce shear stress S_{xy}. In two tests the axial compression stress was maintained constant while applying shear, and the compression strain e_{xx} allowed to increase correspondingly as the shear strain $2e_{xy}$ increased. In a third test, the longitudinal compression strain was maintained constant while applying shear, and the longitudinal compression stress allowed to decrease correspondingly. The maximum strains were approximately 1·6 per cent compression and 0·7 per cent shear on the classical definition. Dr. Peters was kind enough to send me a copy of the N.A.C.A. paper in advance of publication[7].

Each theory states that the 'principal' directions θ, of the strains it considers, coincide with φ, those of the principal normal stresses in an isotropic sub-knowledge of the Peruvian flora. The volume under review (which is written in Spanish) constitutes, therefore, far more than an ordinary second edition, so much has the original material been enlarged. Although it was published in 1945, attention is directed to it here—as a book indispensable to any botanical library—for the reason that it does not yet appear to be widely disseminated east of the Atlantic.

The floristic composition of the whole of Peru is studied, and, as the map of the author's journeys of exploration shows, there appears to be no type of land which he has not visited. Not the least interesting part of the book is the author's account, in the chapter on the history of botanical exploration in Peru, of his tours; the modesty of the diction does not succeed in hiding the magnificent persistence of the explorer, a persistence which has led to such valuable results.

Comparison of the two editions shows that, while the arrangement and the illustrations are substantially the same, the text of the new edition has been completely rewritten and the headings to the material have been clarified in several instances. The list of references numbered 172 in the first edition, but the second edition has 695.

The work is arranged in five sections. An introduction of eighty-two pages contains a history of botanical exploration in Peru from 1568 onwards together with the above-mentioned bibliography, while the first section (pp. 83–138) outlines the physical geography and climate of the country. Section 2 gives a general account of the systematic groups as found in Peru, of the distribution of the plant cover in zones according to altitude, and the composition of the principal formations (pp. 139–219). The third section occupies pp. 221–626 and describes the natural plant cover, region by region, as a basis of phytogeographical classification, a short chapter (pp. 613–626) being devoted to the cultivated plants, American and foreign. The fourth and final section discusses the genesis of the Peruvian flora and possible migratory routes. There is an alphabetical list of plant names, popular and scientific.

While it is not possible to summarize such a large mass of information on a country having so great a diversity of topographical and climatic conditions, attention may be directed, perhaps, to one or two rather unusual plant formations. The word *loma* normally means a gentle slope or hillside, usually covered with low-growing vegetation, and it is used in this sense in the Peruvian Andes. To the Peruvian of the coastal region, however, a *loma* signifies an ephemeral, open plant formation, found not necessarily on slopes and not in immediate proximity to the sea, but in localities open to its influence: the farther the *lomas* penetrate inland, the more they are restricted to the hill tops and crests, until they disappear altogether. The upper limit probably does not exceed a thousand metres, a height seldom attained by the coastal hills; the lower limit is approximately twenty to fifty metres. The principal climatic factor governing the appearance of the *lomas* is the mist of the coastal region, under which they begin to turn green in the middle of winter and dry up at the beginning of summer. The component species are mainly herbs. Annuals predominate, and bulbs and tubers are frequent. There are few grasses and these tend to be scattered. Shrubs are few and confined mainly to the higher parts; cacti (principally *Cereus*) are restricted to dry, stony slopes and are entirely absent from many parts. The dense seasonal mists, seldom penetrated by the rays of the sun, create quite peculiar conditions for plant growth. The general colour, seen from a distance, is an intense green. The description of this formation is of great interest.

Another interesting region on which the present author writes with especial authority is that situated above the level at which agriculture is possible. This region is known as the *Puna* in the middle and south-east of Peru, and its lower limit there is 3,800–4,000 m. In the north of Peru it is known as the *Jalca*, and its lower limit goes down to 3,600 or even 3,400 m., in spite of its closer proximity to the equator. The climate in the north is more humid, cloudy, misty and consequently colder. The upper limit of the *Jalca* seldom exceeds 4,000 m. *Páramo* is another word commonly used to denote these high Andean regions. The flora of the *Puna* and that of the *Jalca* are not identical: rosette-forming herbs and cushion plants are less frequent in the *Jalca* than in the *Puna*; tall, narrow-leaved grasses, mainly species of *Festuca* and *Calamagrostis*, together with shorter grasses and herbs, form a type of steppe in the *Jalca*; and burning by shepherds has modified the plant cover. Detailed floristic descriptions of various sections of these regions are presented.

A third region of which the botany is possibly not very well known is called the *Ceja de la Montana* or the brow of the forest. It comprises the upper, temperate part of the eastern Andean slopes, above the tropical forest which covers the lower slopes up to an altitude of approximately 1,800–2,000 m. Between this and an upper level of 3,400–3,600 m. and (in the middle and south of Peru) even 3,900 m. is found the *Ceja*. A characteristic climatic feature of this zone is mist, which is very frequent at all seasons, originating principally on the crests and peaks exposed to the east winds. The mist not only furnishes much moisture, but also tempers the light and renders the temperature uniform and relatively low. Evergreen woods, varying in height but never attaining that of the tropical forest below, are the dominant formation, alternating in some more sheltered and therefore drier parts with tussock grasslands. Important characters of the woods of the *Ceja* are the profusion of lichens, mosses and ferns, the great quantity of epiphytes, and the firm, coriaceous foliage of many of the woody plants.

G. M. ROSEVEARE

ORIGINS OF SPEECH

The Infancy of Speech and the Speech of Infancy

By Dr. Leopold Stein. Pp. xiv+209+8 plates. (London: Methuen and Co., Ltd., 1949.) 21*s*. net.

DR. LEOPOLD STEIN, who is physician in charge of speech therapy at the Tavistock Clinic, London, has written an extremely learned, but none the less readable, book. He quotes from 266 separate authorities, and engagingly attempts to reconstruct the pre-history of human speech from its earliest beginnings. His English is excellent, and he tells his imaginative story very well. But he suffers from a 'blind spot'; he is convinced that all speech was originally derived from "clicks", such as are found in various African and certain American-Indian languages, and he more or less ignores all other forms of primitive mouth gesture. He makes no reference to Darwin's pregnant observation of the cross-section[4] for some value of the angle of collision, and the results in the remaining angular domain are examined. This permits us to see the angular dependence of the cross-section for each kind of field. (ii) It also seems useful to try to relate the results at low energies with those at higher energies, in looking for the role of the relativistic corrections in the *total* cross-section[3]. Using, for example, a mixture of symmetrical pseudoscalar and vector fields, we get for the total cross-section, in the system of the centre of gravity, and neglecting terms of the fourth order in the momentum p of nucleons :

$$S = S_{NR}\left(1 - \frac{p^2}{M^2}\right) + \frac{p^2 + M^2}{8\pi}\left\{\frac{10A}{\varkappa^2(\varkappa^2 + 4p^2)} - \frac{5A'}{4p^2}\left[\frac{1}{p^2}\log\frac{\varkappa^2 + 4p^2}{\varkappa^2} - \frac{4}{\varkappa^2}\frac{\varkappa^2 + 2p^2}{\varkappa^2 + 4p^2}\right] + \frac{B}{p^2(\varkappa^2 + 2p^2)}\log\frac{\varkappa^2 + 4p^2}{\varkappa^2}\right\}\frac{p^2}{M^2}$$

with

$$A = g_1^3\left(g_1 - 4g_2\frac{M}{\varkappa}\right) + g_2^2\left(4g_2^2\frac{M^2}{\varkappa^2} - f_3^2 - 2g_1^2 + 8g_1g_2\frac{M}{\varkappa}\right)$$

$$A' = g_1^4 + g_2^4 + g_1^3\left(g_1 - 4g_2\frac{M}{\varkappa}\right) - g_2^2\left(4g_2^2\frac{M^2}{\varkappa^2} - f_3^2 - 2g_1^2 + 8g_1g_2\frac{M}{\varkappa}\right)$$

$$B = g_1^2\left(4g_2^2\frac{M^2}{\varkappa^2} - f_3^2 - g_1^2 + 4g_1g_2\frac{M}{\varkappa}\right) - g_2^2\left(4g_2^2\frac{M^2}{\varkappa^2} - f_3^2 - 5g_1^2 + 20g_1g_2\frac{M}{\varkappa}\right) + 8g_1g_2\frac{M}{\varkappa}(g_1^2 + 3g_2^2),$$

where g_1,g_2 are the coupling constants between the vector meson field and the nucleons.

The corresponding non-relativistic cross-section is:

$$S_{NR} = \frac{p^2+M^2}{8\pi}\left\{(g_1^4+3g_2^4)\frac{10}{\varkappa^2(\varkappa^2+4p^2)} + \frac{g_1^4-3g_2^4+6g_1^2g_2^2}{p^2(\varkappa^2+2p^2)}\log\frac{\varkappa^2+4p^2}{\varkappa^2}\right\} \qquad (4)$$

and it does not involve any pseudoscalar coupling constants.

Using, for example, the constants of interaction of the Møller–Rosenfeld theory, $f_1 = g_1 = 0{\cdot}62$; $f_2 = g_2 = 1{\cdot}08$, corresponding to a meson mass 286 m_e, one gets, for incident neutrons of 90 MV. (laboratory system), $S_{NR} = 13{\cdot}5 \times 10^{-26}$ cm.^{2}. The experimental value[7] is approximately 9×10^{-26} cm.^{2}. The non-relativistic cross-section, as in the usual theories, is too large. If we take into account the relativistic terms, we obtain $S = 16{\cdot}2 \times 10^{-26}$ cm.^{2}, showing a further increase in the cross-section. This result is not changed by a more exact evaluation of the cross-section in terms of the velocities of the nucleons. In order to draw more definite conclusions, however, it seems necessary to revise the usual treatment of the ground state of the deuteron by taking account of the velocity-dependent and contact interactions.

I wish to thank Prof. L. Rosenfeld for many valuable discussions, and am also indebted to the Centre National de la Recherche Scientifique for a grant which entitled me to stay at the University of Manchester.

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Meyer Analysis of Metals

Messrs. Finniston, Jones and Madsen discuss in a recent communication[1] the variation of ultimate hardness number Pu with the Meyer index n, in the ball indentation test. There are several good reasons for associating a decrease in the n value with a decrease in the work-hardening capacity of a metal, especially since n and Pu have hitherto shown a negative correlation coefficient. Finniston *et al.*, however, suggest that this generalization should be reconsidered, and they give results showing a positive correlation coefficient between Pu and n for metals of non-cubic structure and of increasing anisotropy as judged by results for thermal expansion. Their proposal is interesting because certain anomalies exist regarding the n value. Thus, during the progressive cold rolling of copper it may drop from 2·34 to 2·0 at an early stage and then remain more or less constant, while the Pu value will continue to increase and thus indicate further work-hardening[2]. This peculiarity has not been explained, and it should be remarked that the progressively rolled copper increasingly develops anisotropic properties (preferred orientation) as shown by X-ray diffraction and etching tests. This effect does not appear to be inconsistent with their proposal.

Furthermore, there is evidence that when a stainless steel 18/8 alloy is progressively cold-worked, the Pu value rises steadily while n first falls and then *rises*. During the tempering of high-carbon steel, Pu will fall progressively but n will first fall and then rise slightly. Finally, in the course of investigations with the new hardness microtesters, results are being obtained where the Meyer index to the pyramid indentation *increases* with cold working as compared with a fall in the normal ball test.

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Jan 16.

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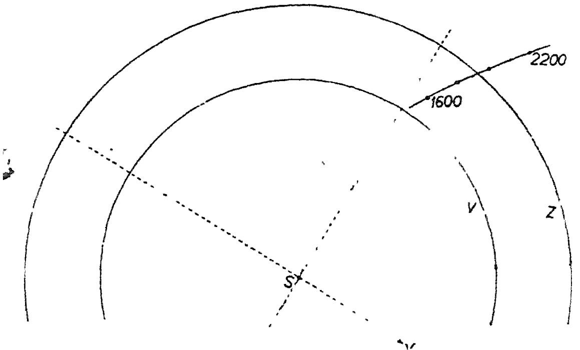
The Geminid Meteor Shower

IN 1947, Whipple[1] published new elements of the Geminid meteor shower, obtained photographically. An extremely short period, 1 65 years, moderate inclination and considerable eccentricity (see below) together make the orbit of this shower an extraordinary one both in comparison with comets and with minor planets. But, according to Hoffmeister[2], the existence of similar meteor showers seems to be indicated. Such a short-period meteor shower as the Geminids presents new aspects in meteor astronomy. Planetary perturbations are likely to play a great part in its nature. The study of secular perturbations is especially important, both in investigating the connexion with comets, and also from the observer's point of view; for example, Adams's classical work on the Leonids.

I have computed secular perturbations of the Geminids, due to Jupiter and the earth, using the Gauss–Hill method. The following table contains Whipple's elements of the Geminid orbit and their variations in a hundred years.

Elements, epoch 1937	Secular perturbations by		Elements, epoch 1937	Secular perturbations by	
	Jupiter	Earth		Jupiter	Earth
π 225° 02′	−0·1′	−1·1′	e 0·900	−0·001	0·000
Ω 260° 43′	−95·0′	−2 2′	a 1·396	—	—
i 23° 28′	+47 8′	+0 7′			

Although the earth approaches the shower very closely in its descending node, the secular perturbations due to it, owing to the small mass, are negligible compared with the effect of Jupiter. As the Geminids do not come near any other planet, perturbations caused by these are likely to be even smaller. The orbit rotates rather rapidly around the line of apsides, the direction of which remains nearly constant.



Secular motion of the descending node of the Geminid orbit on the plane of the ecliptic between the years 1600 and 2200. V, orbit of Venus; Z, orbit of earth

From the observer's point of view, the most important phenomenon is the rapid backward shift of the node. In consequence, the date of maximum activity of the shower moves backward by one day in about sixty years. Moreover (see diagram), the corresponding point of intersection of the Geminid orbit with the plane of the ecliptic does not move parallel with the earth's orbit, but cuts it at a steep angle. Consequently, the least distance of the shower from the earth changes, as the following table shows :

Year	Longitude of the node	Date of the maximum activity	Radius vector of the shower	Distance from earth
			astro unit	
1700	264° 33′	XII 17·7	0 8503	0·1337
1900	261° 18′	14·5	0·9665	0·0178
2100	258° 03′	11·4	1·0912	−0·1066

(Data are reduced to the epoch 1950, see ref. 3.)

The Geminids first appear each year about December 1. On that date, the earth is still about 0·1 astro. unit from the centre of the shower. Let us take this distance as a limit for the visibility of the shower. Then, according to the table, the appearance of the Geminids is limited in time-range to about four centuries. They probably appeared after 1700 and will disappear again about 2100. At present, the orbits of the earth and the Geminids very nearly intersect, and consequently the shower should be of maximum intensity. Before 1700, the Geminids came nearer to Venus than to the earth.

Observations are too few to confirm these theoretical deductions. The time of maximum activity of a shower differs somewhat from the date of the earth's passage through the node. By means of a new method, I have determined the date of maximum and the position of the radiant point with sufficient accuracy. A secular backward shift of the node seems to be indicated by the observations. The secular motion of the radiant point is too small in the time-interval covered by observations for confirmation. There is, however, another striking fact: at the present time, the Geminids are, after the Perseids, the strongest steady meteoric shower. The much feebler Lyrids, for example, have been known for many centuries, while no reports about the Geminids seem to have existed before 1830. Even the nineteenth century has paid little attention to this remarkable shower. This may be partly due to bad and cold December weather, and partly to cosmic causes.

The existence of a parent comet in such a short-period orbit, even in the past, seems to be not very probable. Planetary perturbations could scarcely have reduced the semi-major axis so much. More probably, the Geminids were separated from a parabolic comet by the close approach of the comet to the sun. Malzev[4] considered the possible connexion between the Geminids and the great comet of 1680. He disproved the separation by planetary perturbations. I have fully confirmed his conclusions. Nevertheless, the orbits come near each other a little behind perihelia and in close proximity to the sun; a possible connexion cannot therefore be excluded. Investigations of the age of the shower may throw more light on the subject.

MIROSLAV PLAVEC

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Ratio of Total to Selective Absorption

VALUES of the ratio of total photographic absorption (A) to selective absorption (E) in our galaxy have been found by several investigators. Summaries of various investigations are given by Oort[1] and van Rhijn[2]. The latter adopts a mean value of $A/E_1 = 8 \cdot 2$ (where E_1 is photo-electric colour excess). For the Andromeda nebula, Stebbins and Whitford[3] find $A/E = 4 \cdot 0$.

From an analysis of star counts, the surface distribution of obscuring clouds affecting the stars of photographic magnitude 13·0 within galactic longitudes 290–360° and galactic latitudes ± 30° has been determined. Details will be published in No. 4 of a series of "Contributions from the Armagh Observatory". By comparison with the photoelectric colour excesses of Stebbins, Huffer and Whitford[4], a value has been derived for A/E.

The mean distance of stars of photographic magnitude 13·0 was taken as 1,000 parsecs. Photo-

The Meteorological Office, now a department of the Air Ministry, was founded as the Meteorological Department of the Board of Trade in 1854, but was detached from the Board of Trade in 1867, and entrusted to a Committee of the Royal Society until 1876, when a Meteorological Council was formed to supervise its administration. Later the Council was replaced by an inter-departmental Meteorological Committee, and in 1919 the Office was transferred to the Air Ministry. Duties which we should now perhaps regard as appropriate to the Meteorological Office were, in the earlier years in the lives of the Office and the Society, discharged by the Society. In 1878, recognizing the need for plain and accurate instructions respecting the erection of lightning conductors, the Meteorological Society obtained the assistance of the Royal Institute of British Architects, the Society of Telegraph Engineers and the Physical Society, each of which nominated two representatives to serve with representatives of the Meteorological Society on a conference entrusted with the task of drawing up a detailed report on the subject. The report was published in 1881.

The president's address at the annual general meeting of the Meteorological Society in 1881 (*Quart. J. Met. Soc.*, 7, 94), which was devoted to the history of the Society during its first thirty years, gives the detailed constitution of the conference referred to above. Immediately following this is a reference to the formation of a joint committee of representatives of the Meteorological Council and of the Society to consider the question which had been propounded by the Austrian Government "relative to the alleged recent diminution in the Water Supply over a considerable part of Europe". The same question might very well have been propounded in 1949, when over wide areas of Europe the water supply was deficient for some months.

Experiments on wind-pressure on structures, prompted by the Tay Bridge disaster in a severe gale in 1879, were undertaken in collaboration with the Meteorological Office by Mr. W. H. Dines, acting on behalf of the Society. Many of the ingenious experiments carried out by Mr. Dines in the course of this investigation were described in the *Quarterly Journal*, and discussed at meetings of the Society. One of the principal results of this work was the evolution of the Dines pressure-tube anemometer, while the importance of securing comparable exposures for anemometers was clearly demonstrated. Dines showed that, while it may be assumed that the pressure of wind on a flat plate in lb./ft.^{2}, with speed v in m.p.h., may be represented by kv^2, the value of k is more nearly 0·003 than the value 0·005 previously assumed by engineers.

The Society initiated in 1875 the series of annual *Phenological Reports*, which give the dates of first appearance of flowers, birds and insects, and which attempt to correlate these dates with the weather of the current or earlier seasons. These reports were continued without intermission up to 1947.

During the whole period of its existence, the *Quarterly Journal* of the Society has held an honourable place in the literature of meteorology. For many years, in addition to original papers, it contained the only available monthly summaries of weather for England and Wales, and thereby rendered a valuable service to the public.

In its earlier years, the Society was essentially an association of amateurs of the science of meteorology, who were inspired by the desire to add to our knowledge of the atmosphere. Many of these amateurs attained great distinction. Thus W. H. Dines, who started as a trained mechanical engineer, became an enthusiastic amateur meteorologist, and designed, and himself used, a number of ingenious instruments, of which the Dines anemometer was mentioned earlier. He also designed recording instruments for temperature and pressure, suitable for sending up on kites and unmanned balloons, obtaining results which he discussed in a series of papers to which the meteorologist of to-day frequently refers. Dines also designed an ingenious instrument for measuring the amount of infra-red radiation reaching the earth's surface from the atmosphere, and the discussion of the observations which he obtained by the use of this instrument has produced papers of considerable value by Dines, by Dines and his son, L. H. G. Dines, by Sir George Simpson, and by a number of other meteorologists both in Great Britain and elsewhere.

In 1881 the Society commenced a series of exhibitions of instruments, and these continued at intervals of a year, except for a few omissions, up to 1900, when fourteen had been held. The Society's publications do not give any indication of such exhibitions being held after that of 1900.

An important step in the development of the Society came in 1921. The Scottish Meteorological Society, founded in 1855, had devoted its energies mainly to the study of the meteorological problems of Scotland, with Dr. Alexander Buchan as its organising genius. It maintained an office in Edinburgh under a working agreement with the Meteorological Office. When in 1919 the Meteorological Office was transferred to the Air Ministry, and the Meteorological Committee was reconstituted, a branch of the Meteorological Office was established in Edinburgh. This branch office took over the responsibilities of the Scottish Meteorological Society in regard to the collection and compilation of statistics, and the supply of information to the public. Since this involved the transfer of responsibility for the observational work in Scotland from the Scottish Meteorological Society to the Meteorological Office, it came to be felt that closer co-operation between the Society and the Royal Meteorological Society would be beneficial to both Societies, and to the science of meteorology. The incorporation of the Scottish Meteorological Society in the Royal Meteorological Society was effected in 1921, when 124 members of the former Society became Fellows of the latter.

The number of Fellows, which was about 150 in 1851, had steadily grown to 620 by 1900; then, after falling to 558 in 1910, it had again grown to 795 by 1920, as the result of the First World War. In 1930 it had fallen to 775, in spite of the accretion of new Fellows on the incorporation of the Scottish Meteorological Society. The Second World War, in which the official meteorological service grew with amazing rapidity, had immediate repercussions on the Society, and the fellowship grew from 879 in 1940 to 1,714 in 1947, with a slight fall to 1,654 in 1950.

A detailed account of the work of the Society during the first thirty years of its existence was given by Symons in his presidential address in 1882. In 1900 the Society celebrated its jubilee on April 3, with a commemoration meeting attended by delegates from other learned societies, held during the afternoon, followed by a conversazione in the evening. The next day was devoted to a visit to the Royal

Observatory, Greenwich, followed by a visit to the Painted Hall and Naval Museum of Greenwich Hospital, and by a dinner in the evening. At the commemoration meeting the president, Dr. Theodore Williams, welcomed representatives of many learned societies, and many letters received from famous foreign men of science were read. The celebration of its jubilee brought the Society many warm tributes, from which it is clear that the Society held a high place in the esteem of meteorologists all over the world.

The growth of the Society, as sketched briefly above, has been very strongly affected by each of the two World Wars. When the Society was first formed, there was no official meteorological service in Great Britain, and so there were no official meteorologists. Moreover, there were no departments of meteorology at any of the universities. In consequence, the fellowship of the Society could only be recruited from amateur meteorologists. Even in 1910, the Meteorological Office had only five graduates on its staff, including the director, Dr. W. N. Shaw (later Sir Napier Shaw).

Each of the two World Wars brought into meteorology large numbers of young graduates, of whom many joined the Society. They were brought into contact with many problems of a new type, and when they were free to publish the results of their work they were able, after the First World War, to give the *Quarterly Journal* a definite swing in the direction of more detailed discussion of conditions in the free air, in the light of observations which had been accumulated during the War by the use of thermometers on aircraft, and by the use of pilot balloons. Papers on the distribution of temperature in the upper air, on the form of clouds seen from aircraft, on the physics of cloud formation, and other related topics, are to be found in the *Journal* in the early 1920's.

In the course of the inter-war years, partly, at least, through the influence of discussions at the meetings of the Society, there arose a tendency to subject the problems of meteorology to an analytical mode of discussion. This tendency became even more marked in the late 1940's, and many recent numbers of the *Quarterly Journal* have contained papers of a highly mathematical character. The Second World War had brought into being a number of new types of instruments, and far more extensive observations of conditions in the upper air. The latter had a marked effect in emphasizing the three-dimensional nature of the atmosphere, and raised in an acute form the problem of how best to represent on a two-dimensional chart the three-dimensional observations which had been made possible by the application of radar and radio to the problem of making measurements of temperature, humidity and wind in the upper air. In providing a forum for the critical discussions on such varied topics as have come before it, the Society has made a considerable contribution to the advance of meteorology.

It is not to be inferred that we can now enumerate recent advances in meteorology in a simple form. The science is more excitingly alive at present than it has ever been, and the meteorologist of to-day can look forward to a rapid advance of our knowledge of atmospheric processes.

At several stages in its history the Society has been faced with the problem of how best to deal with the widely varying character of the papers submitted for publication. The fellowship of the Society has at all times included numbers of amateurs of meteorology, who find papers of a highly specialized character beyond their comprehension. These readers of the *Quarterly Journal* have sometimes found a whole issue too technical to understand.

The first effort to overcome this difficulty was the initiation in 1926 of the publication of the highly technical papers as separate *Memoirs*, of which forty numbers appeared, before the venture was abandoned in 1939. This solution of the problem was never wholly satisfactory, as there was no hard-and-fast rule to determine which papers should go into the *Journal* and which should appear as *Memoirs*. An effort was at the same time made to include articles of general interest in the *Quarterly Journal*. In 1930 a series of articles entitled "Problems of Modern Meteorology" was initiated. Each article dealt with one aspect of meteorology, and was devoted to a critical summary of the appropriate theories, with a bibliography. This series was continued for four years, and the Council decided to reproduce in book form the sixteen papers which had been contributed by various authors. This was the first time that special articles had been written for publication in the *Journal* without having been read and discussed at meetings of the Society.

In 1945 the Council adopted a second solution of the problem of separating papers of general interest from the more technical papers, by the bold step of publishing a new semi-popular monthly magazine, entitled *Weather*, containing matter of general interest. This magazine is well illustrated and attractive, both in appearance and content. In it are published news, articles describing in simple terms the progress of research in special aspects of meteorology, summaries of a wider field of meteorology in a readable form, and letters from readers. *Weather* has been very well received both in Great Britain and abroad, and has thoroughly justified the risky step taken in launching it at a time of rapidly rising costs of publication.

The Society has a number of awards which can be given for distinguished work in meteorology. The highest honour which it can bestow is the Symons Memorial Medal, which is awarded every other year, "for distinguished work in meteorological science", irrespective of sex or nationality. The Medal, which was of gold up to the early years of the Second World War, is provided from funds which were subscribed by Fellows of the Society in 1900 and 1901, to provide a memorial to Mr. J. G. Symons, F.R.S. It was first awarded in 1902 to Dr. Alexander Buchan, F.R.S., and in general it has been awarded alternately to a British and a foreign meteorologist. The complete list of twenty-four recipients contains all the outstanding meteorologists of the past half-century.

At the time of the amalgamation of the Scottish Meteorological Society with the Royal Meteorological Society in 1921, it was suggested that part of the funds of the former Society should be devoted to the award of a prize, which might appropriately be called the "Buchan Prize", in order to commemorate Scotland's most widely known meteorologist. This suggestion was put into effect, and in 1925 the first award was made to Mr. W. H. Dines. The Buchan Prize, which consists of fifteen guineas, together with a parchment certificate, has been awarded in alternate years, generally in the years when no Symons Medal was to be awarded. Only Fellows are eligible for the Prize.

The present is a time of great activity in meteorology, and the output of papers on the subject is far greater than it has ever been, and covers a far wider field than at any time in the past. The primary function of the Royal Meteorological Society in the years now ahead will be to provide a forum for truly critical discussion of the papers submitted to it. Only in this way can it help to sift from the great mass of work now being published the part which has permanent value.

A secondary function, which it has fulfilled in the past and should continue in the future, is that of the dissemination of knowledge and understanding of meteorology. At several stages in its history the Society has arranged series of free popular lectures, open to the general public, and these lectures have been much appreciated by good audiences. It is in this way that the Society can help to demonstrate that meteorology is concerned, not only with forecasting to-morrow's weather, but also with almost every aspect of human life.

The centenary of the Royal Meteorological Society will be celebrated by a series of symposia to be held in Oxford during March 28–31; a conversazione in the Society's Rooms at 49 Cromwell Road, South Kensington, S.W.7, on Saturday, April 1, preceded in the afternoon by a visit to the Meteorological Office, Harrow; and on Monday, April 3, a morning visit to the Department of Meteorology, Imperial College of Science and Technology, South Kensington, the centenary meeting in the Society's Rooms at 3 p.m., followed by a dinner at the Connaught Rooms, Great Queen Street.

THE CYCLOSYNCHROTRON

Acceleration of Heavy Particles to Energies above 1,000 MeV., and the Homopolar Generator as a Source of very Large Current Pulses

By Prof. M. L. OLIPHANT, F.R.S.

ADVANCE in the frontier problems of nuclear physics and of field theory appears to await the results of experiments with particles accelerated to very high energies. Such particles are present in cosmic radiation, especially at high altitudes, and much information can be obtained from them. However, some experiments, such as accurate observations of scattering, are difficult, if not impossible, with cosmic radiation. The great contributions made to knowledge in this field through the operation of the 184-inch synchrocyclotron in Berkeley indicate the unique value of beams of particles, with energies in the cosmic-ray region, when available in the laboratory.

The acceleration of electrons to very high energies probably depends upon the development of linear accelerators of great length, since the curling up of the path of an electron, by means of a magnetic field, into a circle of reasonable radius leads to prohibitive radiation losses when moving at extreme relativistic speeds. On the other hand, loss of energy by radiation from heavy particles moving in strong magnetic fields is negligible for any final energy contemplated at the present time. It has been shown by Veksler[1] and McMillan[2] that the orbits of relativistic particles undergoing acceleration in a synchrotron are stable against radial and axial oscillations, and that the bunched particles possess phase stability. Gooden[3] and others have considered synchrotron acceleration in the non-relativistic region of velocities and have shown that the orbits and phases can be made stable. The magnetic field thus serves not only to curl up the very long paths of the particles during acceleration, so as to keep them within the confines of the laboratory, but also to impart stability in position and phase which compensates for initial divergence of the beam, small-angle scattering in the residual gas and for reasonable geometrical imperfections in the apparatus.

The kinetic energy W, and radius of curvature ρ, of a charged particle of rest-mass m_0, moving at right-angles to a magnetic field H, are related by the expression

$$H\rho = \frac{m_0 c}{e} \sqrt{\left(\frac{W + m_0 c^2}{m_0 c^2}\right)^2 - 1},$$

and for protons this becomes

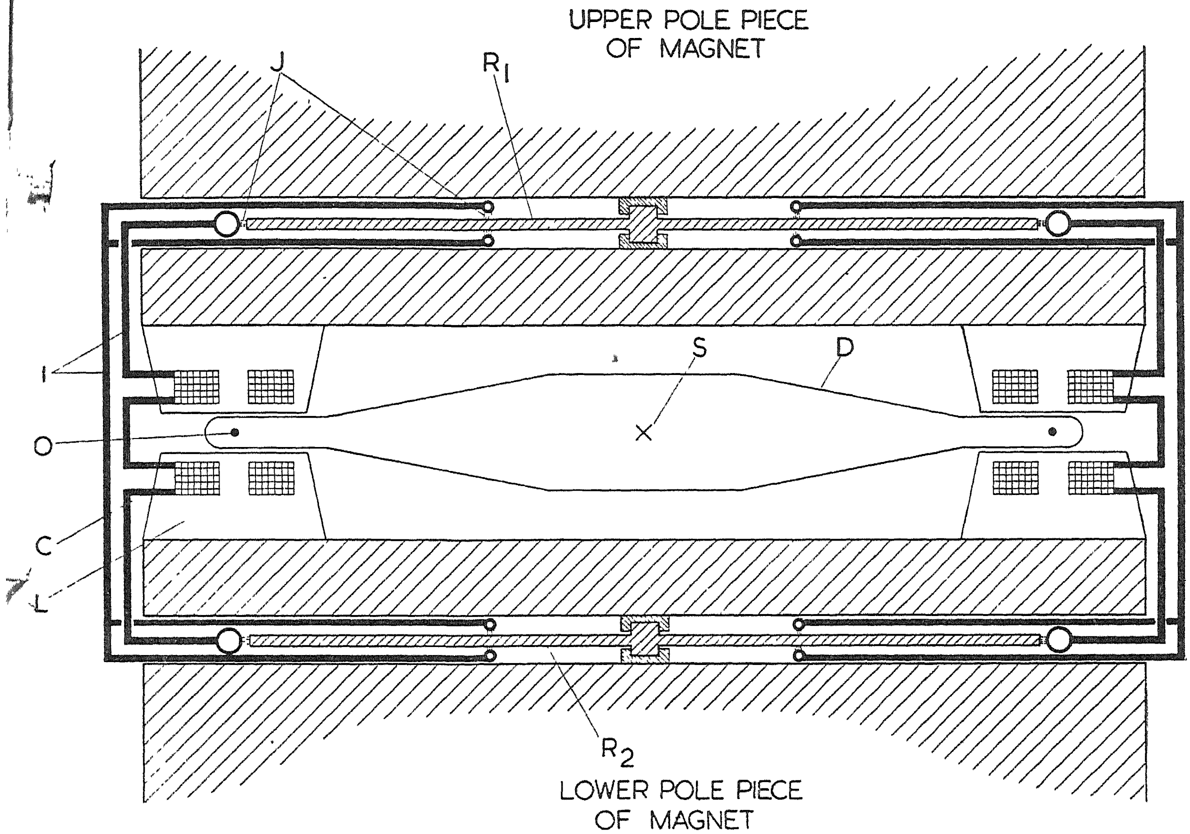
$$H\rho = 3{\cdot}13 \times 10^6 \sqrt{\left(\frac{W}{0{\cdot}94} + 1\right)^2 - 1},$$

where W is in units of 10^9 eV., H is in gauss and ρ in cm. For protons with an energy of 2×10^9 eV., $H\rho$ is therefore $9{\cdot}3 \times 10^6$ gauss-cm.

The inevitable radial and axial oscillations undergone by the particles as they rotate in the guiding field make it necessary to provide a reasonable aperture over which the magnetic field has the correct value. This aperture will be greater the lower the energy at which the beam is injected, and its linear dimensions will increase proportionally with ρ. Thus the magnetic energy stored at the peak value of the magnetic field of a synchrotron is proportional to ρ. This magnetic energy is by far the most difficult and expensive quantity which must be provided for a synchrotron. It is clear that it pays to use as large a value of H as is practicable. Iron-cored magnets, which must be laminated, cannot provide a peak field greater than about 15,000 gauss, so that, for an energy of 2×10^9 eV., ρ is about 620 cm., giving a magnet about 45 ft. in diameter. However, if H can be increased to about 62,000 gauss, by the use of current-carrying coils without iron, ρ shrinks to 150 cm.

If the beam of particles can be injected into the synchrotron orbit at a very high energy, the effects of scattering in the residual gas and of departures from the correct frequency on the accelerating electrode are greatly reduced, and the aperture of the field can be made correspondingly smaller. If, in addition, the beam is injected already bunched and correctly phased with respect to the accelerating gap, practically all the particles will be captured into stable synchrotron orbits. A further advantage of injection at very high energy is that the radio-frequency applied to the accelerating electrode must be varied during acceleration over a much smaller range. One of the most serious problems in the design of the $1{\cdot}3 \times 10^9$ eV. proton-synchrotron in Birmingham[4], into which particles are injected at an energy of 5×10^5 eV., has been the provision of an accelerating potential varying in frequency from 0·25 Mc. at injection to a final value of 10 Mc.

It is possible to meet most of these desirable conditions by first accelerating protons in a synchrocyclotron and then producing a synchrotron guiding field about the final orbit, in such a way that the



SCHEMATIC DIAGRAM OF THE CYCLO-SYNCHROTRON

Protons or other heavy particles from the source *S* are accelerated by the electrode *D* of the synchro-cyclotron system to a final orbit *O*. A synchrotron field is produced about *O* by the coils *C*, which are fed with a rising current pulse from the homopolar generator rotors R_1 and R_2, the circuit being completed when the protons reach *O* by the liquid sodium jets *J*, which are interrupted at the end of a full cycle when the current is zero. The radio-frequency applied to *D* falls during the synchrocyclotron acceleration and increases again during the synchrotron acceleration in the orbit *O*

synchrocyclotron acceleration passes smoothly over into synchrotron acceleration. We have called an accelerator operating in this way a 'cyclo-synchrotron', and a first model is under construction for installation in the School of Physical Sciences in the Australian National University at Canberra.

The synchrocyclotron magnet will have a pole diameter of 136 inches with a gap of 14 inches, the mean magnetic field being about 15,000 gauss, and will produce protons with an energy of 200 MeV. in a final orbit 150 cm. in radius. This synchrocyclotron will be a valuable instrument in itself for studies in nuclear physics in the energy-region up to 200 MeV. Suitable coils will be arranged about the final orbit so as to produce in this region a synchrotron field rising to about 65,000 gauss, giving particles with an energy of 2×10^9 eV. Higher values of the field would lead to distortion of the water-cooled copper coils, but by the use of beryllium-copper and improved forms of support, it may be possible to double the stress, that is, to increase the field by 40 per cent, when the final energy of the accelerated particles would be $3{\cdot}3 \times 10^9$ eV.

A schematic cross-section of the new accelerator is given in the figure. A more detailed technical description will be given elsewhere. With synchrocyclotrons of the size of some existing in the United States to-day, it may be possible to construct cyclo-synchrotrons capable of producing protons with energies of $5\text{–}6 \times 10^9$ eV., which should be sufficient for most of the crucial experiments foreseen at the present time.

From the technical point of view, the most difficult problem to be faced is the provision of the pulses of current through the synchrotron coils. In order to avoid insulation troubles and to enable the windings to be properly transposed, each of the four coils in the Canberra accelerator contains effectively only a single turn, in which the copper cross-section is 96 cm.^{2}, the leads to the separate conductors, which are water-cooled, being brought out symmetrically distributed about the circumference, so as to avoid serious inhomogeneities in the field. The four coils are in series, giving a resistance of less than 10^{-4} ohm. A current of about 10^6 amperes is required to give a synchrotron field of 65,000 gauss, and if the time of rise is to be of the order of 1/10 second a potential of 500 volts is needed. The energy stored in the magnetic field is about 5×10^6 joules.

Discussion with the makers of switch-gear testing equipment indicates that it is extremely difficult or impossible to provide pulses of energy of this magnitude by conventional methods. In a search for an alternative source of pulsed energy, we found that the disk-type homopolar generator offers the most practicable solution. Two generator disks will be mounted in the auxiliary gaps in the magnetic circuit shown in the figure. These rotors will be 300 cm. in diameter, will rotate at a maximum speed of 20 revolutions per second in a field of 17,000 gauss, and will generate 250 volts each between the periphery and an inner current-collecting circle 100 cm. in diameter. The disks will rotate in opposite directions and will be connected in series with one another and with the synchrotron coils. They will rotate in closed chambers in an atmosphere of hydrogen. Current will be collected at the periphery and at both sides of the inner collecting circle by means of jets of liquid sodium issuing from slots in circular channels; and by using mechanism similar to the fuel injection system of a Diesel engine, these jets will make contact when a pulse of current is required, so that they serve also as a switching system.

If the current from the disks is led back from the inner current-collecting rings symmetrically about the disks, through copper linings insulated from the steel pole-pieces, there will be no resultant axial forces on the disks. With rotors about 1 cm. thick, the total rotational energy stored in the disks is about 7×10^6 joules. This corresponds with an effective 'capacity' of the disks of the order of 100 farads, and, when connected in series with the inductance of the synchrotron coils, they form an oscillating circuit in which energy is handed over to the magnetic field and back into the disks. The current can be interrupted as it passes through zero after a half period, when the direction of rotation of the disks is reversed, or after a full period, when they are again spinning in the original direction. The fraction of the energy lost in resistance and windage, etc., in a full cycle, is about three-quarters of the total initial energy, so that about 1,000 kilowatts is necessary to drive the rotors if the system is pulsed at 10-second intervals. The rotors will be driven as disk motors.

A model of the homopolar generator is being built with a rotor 18 inches in diameter in order to settle the details of current collection.

The disk-type homopolar generator is attractive as a short-circuit type generator for relatively low voltages and very high currents. The armature reaction is virtually zero, the resistance is very small, the stresses in the disk are well within the strength of ordinary materials, and it is to be noted that in this application the maximum stress due to the current occurs when the centrifugal stress is zero, that is, when the disk is at rest. These properties of the homopolar generator may render it useful in other applications.

By building the generators into the synchro-cyclotron magnet itself, the need for a separate magnet is removed at the expense of extra ampere-turns on the windings, and the very short current leads to the synchrotron coils eliminate many of the difficulties of using such heavy currents at low voltages.

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[2] McMillan, *Phys. Rev.*, **68**, 143 (1945).

[3] Gooden, Jensen and Symonds, *Proc. Phys. Soc.*, **59**, 677 (1947).

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NEW FELLOWS OF THE ROYAL SOCIETY

AT the meeting of the Royal Society held on March 16, the following were elected to fellowship:

Dr. B. P. Babkin, physiologist, McGill University, Montreal; distinguished for his work on the secretion by the digestive tract and on conditioned reflexes.

Prof. L. F. Bates, professor of physics, University of Nottingham; distinguished for his contributions to experimental physics, particularly for his researches on the properties of ferromagnetic substances.

Prof. T. A. Bennet-Clark, professor of botany, King's College, London; distinguished for his researches in plant physiology, particularly on organic acid metabolism, and the control of water in plant cells.

Dr. B. Bleaney, demonstrator and lecturer in physics, University of Oxford; distinguished for his contributions to experimental physics, especially to microwave spectroscopy and to low-temperature physics.

Dr. L. J. Comrie, director of the Scientific Computing Service, Ltd., London; distinguished by his contributions to modern methods of computation.

Prof. C. A. Coulson, professor of theoretical physics, King's College, London; distinguished for his application of quantum theory to chemical problems.

Dr. L. R. Cox, assistant keeper, Department of Geology, British Museum (Natural History); distinguished for his contributions to invertebrate palæontology.

Prof. H. S. M. Coxeter, professor of mathematics, University of Toronto; distinguished for his discoveries in geometry and in particular for his work on polytopes.

G. H. Cunningham, director of the Plant Diseases Division, Department of Scientific and Industrial Research, Auckland, New Zealand; distinguished for his researches on the rust fungi and systematic mycology.

Dr. W. J. Elford, biophysicist, National Institute for Medical Research, London; distinguished especially for his researches on viruses, particularly on methods of determining virus size.

S. B. Gates, a senior principal scientific officer, Ministry of Supply (Air); distinguished as a pioneer in the scientific study of the dynamics of aircraft.

Dr. C. A. Hoare, protozoologist to the Wellcome Laboratories of Tropical Medicine, London; distinguished for his work on parasitic Protozoa, especially the trypanosomes.

Prof. L. Howarth, professor of applied mathematics, University of Bristol; distinguished for his contributions to the mathematical theory of the boundary layer, the theory of isotropic turbulence and gas dynamics.

Prof. E. R. H. Jones, professor of organic chemistry University of Manchester; distinguished for his research in organic chemistry, particularly in the fields of steroids, carotenoids and in the chemistry of acetylene.

Dr. A. J. P. Martin, biochemist, National Institute for Medical Research, London; distinguished for his work on the development of liquid-liquid partition chromatographic methods of chemical analysis.

Dr. D. F. Martyn, principal scientific officer, Commonwealth Scientific and Industrial Research Organisation, Solar Observatory, Canberra; distinguished for his contributions to various aspects of scientific radio, including the interpretation of radio wave interaction and the elucidation of ionospheric variations.

Prof. R. A. Morton, professor of biochemistry, University of Liverpool; distinguished for his studies in the chemistry and biochemistry of the fat-soluble vitamins.

Prof. R. J. Pumphrey, professor of zoology, University of Liverpool; distinguished for his researches on the sense organs and central nervous system of animals, particularly for his work on hearing in insects and man.

Prof. A. G. Shenstone, professor of physics, University of Princeton; formerly scientific liaison officer in London of the Canadian National Research Council; distinguished for his spectroscopic researches.

Prof. H. E. Shortt, head of the Department of Parasitology, London School of Hygiene and Tropical Medicine; distinguished for his work on protozoal diseases.

Prof. M. Stacey, professor of chemistry, University of Birmingham; distinguished for his researches in organic chemistry, especially his studies of the carbohydrates of animal tissue and of micro-organisms.

Dr. L. E. Sutton, demonstrator and lecturer in physical chemistry, University of Oxford; distinguished for his work on the electrical properties of molecules.

R. L. M. Synge, biochemist, Rowett Research Institute, Aberdeenshire; distinguished for his application of the principle of partition chromatography to the separation of amino-acids and peptides.

Dr. B. P. Uvarov, director of the Anti-Locust Research Centre, British Museum (Natural History); distinguished for his scientific researches on the Orthoptera and for the leading part he has played in the international organisation of measures for the control of locusts.

Prof. F. C. Williams, professor of electro-technics, University of Manchester; distinguished for his work on radar and the development of electrical computing machines.

NEWS and VIEWS

Botany at Manchester:

Prof. S. C. Harland, F.R.S.

Dr. S. C. Harland, reader in genetics in the University of Manchester, has been appointed Harrison professor of botany and director of the Laboratories and Experimental Grounds, in succession to Prof. Eric Ashby, who was recently elected president and vice-chancellor of Queen's University, Belfast (*Nature*, October 22, 1949). Dr. Harland has had a distinguished career in economic botany and is one of the leading authorities in the world on plant genetics. He graduated at King's College, London, and he has been successively head of the Botanical Department of the Shirley Institute, professor of botany and genetics in the Imperial College of Tropical Agriculture, chief geneticist to the Empire Cotton Growing Corporation, and director of the Institute of Cotton Genetics of the National Agricultural Society of Peru. Dr. Harland's principal contributions to genetics have been made with the cotton plant, and his book "The Genetics of Cotton" is the standard work on the subject. His researches are remarkable for their boldness of approach and their relevance not only to cotton breeders, but also to plant geographers and experimental taxonomists. Dr. Harland is an inspiring teacher and a man of wide interests, so it is a matter of great satisfaction that he has been called upon to maintain the high tradition of botany at the University of Manchester.

Scientific Freedom and Security in the United States

The Council of the U.S. National Academy of Sciences has submitted to President Truman a statement relating to certain provisions of the National Science Foundation Bill HR 4846 as passed by the House of Representatives on March 1. After referring to the main object of the measure, the statement continues: "One set of protective measures is rightly aimed at the security of information vital to the national defense. Scientific and technical information has come to play an important role in this defense. We are gravely disturbed, however, to see that security measures are being extended widely over the scientific life of the country, even in those areas remote from possible military application. This development will defeat the growth of science by inhibiting the free exchange of information so vital to it, by discouraging the bravest and most original minds, and by the pervasive threat of irreparable injury to individuals inherent in all counter-intelligence measures. If we are concerned with these developments it is not because we ask a special privilege for scientists; it is because they cannot lose their freedom without jeopardizing the freedom of all Americans."

In his covering letter to President Truman, Dr. Alfred N. Richards, president of the Academy, points out that the statement "is designedly limited to principles so broad as to be applicable not only to science but to other intellectual pursuits. It has developed, however, from more specific considerations." The Academy is particularly concerned about the amendment providing "for FBI investigation and clearance of every person who is to be awarded a scholarship or fellowship under the terms of the bill". While it is agreed that such precautions are necessary in dealing with those who work in classified fields or have access to restricted data, to submit large numbers of young persons to such investigations is unnecessary and may even be positively detrimental to the objectives of the bill. "Knowledge of the nature of FBI investigations and reports among prospective applicants for scholarships may well be expected to develop in them habits of caution, reticence and suspicion, which are the antithesis of frank truthfulness which science demands. A deplorable trend to conformity and a deterioration in the intellectual climate could be expected to follow." In conclusion, Dr. Richards said that the statement was "the basis of the decision of the National Academy of Sciences to limit the participation of the National Research Council in the non-secret part of the AEC fellowship program to advisory assistance".

Annual Report of the Imperial College of Tropical Agriculture

THE 1948 annual report of the Imperial College of Tropical Agriculture, St. Augustine, Trinidad (London office, 40 Norfolk Street, London, W.C.2), comes at an important period of its post-war development. On one hand, the College is now closely associated with four adequately financed Colonial Development and Welfare Acts research projects dealing with banana, cacao, cane sugar and soils; on the other hand, working arrangements are being formulated with the University College of the West Indies, and contacts are being made with the University Colleges in the Gold Coast, Nigeria and Uganda. In Trinidad, as elsewhere, urgent research projects are at present impeded by lack of housing or of laboratory accommodation and by lack of staff. Construction costs have risen, and some modification of original designs has been necessary. It is satisfactory to note that three hundred acres of land in the new College farm are being cleared and planted; the College has hitherto had insufficient land for field experiments. Some appointments have been made to the teaching and research staff. It is considered that the introduction of equivalent salary scales will be greatly advantageous in attracting good men and in facilitating interchange between scientific workers in the West Indies, in the Colonial Research Service and in the Scientific Civil Service of Great Britain.

Another feature in plans for Colonial development is the grouping of overseas men of science in research organisations where they benefit from contact with fellow workers, have adequate libraries and can be relieved of various administrative chores. A regional agricultural research organisation has not yet been established in the British West Indies, but the Imperial College of Tropical Agriculture does, in fact, carry out some of the desired functions. It seems necessary to assume that as time passes an increasing amount of agricultural research, development and extension work in tropical lands will be carried out by nationals of those countries. Nevertheless, these territories will continue to require technicians who have received their general education and their more specialized training in metropolitan countries. These two aspects of man-power needs in relation to agricultural development have to be borne in mind when planning the most fruitful co-operation between regional research organisations and regional university colleges. The discussions that are in progress between the Imperial College of Tropical Agriculture and the University College of the West Indies will, it is hoped, lead towards a well-devised and adjustable allocation of responsibilities in this field.

Parliamentary and Scientific Committee: Annual Report

THE annual report for 1949 of the Parliamentary and Scientific Committee (pp. 20; London: Parliamentary and Scientific Committee, 1949; 1*s*.) gives an account of the Committee's activities which demonstrates what an important contribution this unofficial body can make in bringing scientific opinion to bear effectively on the conduct of public affairs. A useful series of addresses was given to meetings of the Committee during the year on such varied matters as American technological co-operation, the British Standards Institution, science and the efficient use of materials in the building industry, Britain's oil-refinery programme, the Agricultural and the Medical Research Councils and the World Resources Conference. Questions were put in the House of Commons by Mr. Raymond Blackburn, chairman of the sub-committee on coal utilization, which led to important announcements on the re-organisation of research and development under the Minister of Fuel and Power, the efficiency of coal utilization and on smoke abatement. Representations were made during the year on the importation of scientific books and journals, on Anglo-American co-operation and President Truman's Fourth Point, and on sera and vaccines for veterinary use. A sub-committee on technical education took evidence with the object of producing a report on technical education in sequel to those issued on scientific man-power and higher technological education. Other aspects of scientific man-power and technological education were raised by members of the Committee in the House of Commons during the year; but, while a sub-committee was appointed to consider the effect which the implementation of the Spens report would have on the scales for university salaries, no action on the part of the Parliamentary and Scientific Committee was called for in view of announcements made by the Chancellor of the Exchequer on February 28 and March 15, 1949.

Turnover of Industrial Labour in Great Britain

THE British Institute of Management has now published an analysis of labour turnover statistics submitted by 187 undertakings, covering 215,499 male and 94,875 female employees for the period January–June 1949, in response to an invitation issued in November 1948 with the booklet of the Institute, "Labour Turnover". The returns cover thirty-seven industry groups and thirteen localities. Three tables are given: the first lists the industry groups and shows the number of establishments included in each group, and a percentage analysis of leavers in various categories; the second gives half-yearly totals for thirty-seven industry groups and five locality groups, showing the total number of leavers in each group for each of twenty-three reasons for leaving; the third table gives the annual labour turnover-rate, the resignation-rate and the rate of resignations for works reasons. Analysis of this third table indicates the very low annual labour turnover-rate for both males and females in the oil and petroleum industry. By far the greater proportion of this low rate for both males and females is made up of resignations, and of these resignations less than forty per cent for men and less than thirty per cent for women are resignations for works reasons. In most industries the proportion of resignations among women is very high compared with discharges, and resignations for other than works reasons predominate, whereas among men a high proportion leave for works reasons. Full six-monthly analysis sheets for each industry group and, where possible, each locality group have been distributed to the undertakings participating in that industry and locality, and copies are available for inspection at the Institute.

Sciences Modernes

THE first number of a new Belgian monthly, *Sciences Modernes* (pp. 32; Jumet-Charleroi: 4 rue Remoncheval, 1950; 250 francs a year), indicates that its appeal lies more particularly in the field of applied science; but it expects to find its readers among those who wish to be kept up to date with regard to developments in technology during and since the Second World War. The editor, M. J. Georges, signalizes the present epoch as one in which pure science steps down from its academic seat and mingles with the workers in industry. He rightly senses that the latter have not at present the leisure to delve into the specialized journals in the hope of finding scientific facts that they may apply in their work. The moment should, therefore, be propitious to launch a review which will let the technician know what is being done in applied physics—more particularly in electricity—and chemistry in language which, without despising the formula and the diagram, should be readily understood by him. The first number contains articles on the electrification schemes of the Belgian railways, a new thermodynamic cycle, motors for aircraft, the manufacture of photographic films, and the applications of thermionic valves—all, with one exception, by Belgian authors. They seem well written from the point of view of the reader, particularly of the young technologist in industry, and are calculated to show him the wide range which physical science now covers in its applications. In welcoming this new periodical, we note with interest that it is hoped soon to issue a version for English-speaking readers, as well as translations in Dutch and German, and to enlist the collaboration of men of science outside Belgium.

The New Naturalist

LIKE the second, the sixth number of the recently launched journal, *The New Naturalist*, is devoted to a natural region of the British Isles; then, it was the Western Isles of Scotland, and now, in contrast, East Anglia. The multiplicity and complexity of the fauna and flora of the Broads and the Breck, marshes and the meres, swamps and shores of Norfolk and Suffolk have long made them the home of many of Britain's most enthusiastic naturalists. Natural history societies were formed and working in Norfolk long before they had appeared in most other parts of Britain, and it is not surprising, therefore, that this issue of *The New Naturalist* should be of high standard. Prof. Darby, the fens historian, and J. N. Jennings and J. M. Lambert describe how the country has been changed by man, while Prof. J. A. Steers discusses geological changes in the coast-line. E. A. Ellis and Dr. A. S. Watt consider the natural history of the Broads and the Breck, while the special problems presented to students by a group like the rushes are elaborated by Dr. Paul Richards. Two well-known naturalist families in East Anglia are represented by the late Dr. R. Gurney and Major A. Buxton, who write about aquatic life in the Norfolk Broads and sportsmen's activities in Norfolk respectively. Dr. E. A. R. Ennion shows how much Flatford Mill Field Centre is contributing to the development of natural history studies in East Anglia, and Dr. D. Lack introduces an ornithological examination paper which was recently 'set' at a social evening in Oxford and which should provide many ornithologists with much diversion but few marks. The illustrations have been chosen with keen discrimination and executed to give delight to all who see them.

Horticulture of Aroid 'Lilies'

THE American Plant Life Society has devoted Volume 4 of "Plant Life", its year-book for 1948 (Stanford, Calif.; n.p.), to the aroid or calla 'lilies'. Chief among the various regional and floristic papers is a detailed description of species of the genus *Zantedeschia*, by Dr. Hamilton P. Traub. This genus was proposed by Sprengel in 1826, to accommodate the South African species of the Linnæan genus *Calla*. Eight species are described in detail, with illustrations, and many garden forms and hybrids are also mentioned. A key is provided, and horticulturalists should find much useful knowledge in this paper.

Scientific Papers Published in the Middle East

THE fourth number of the "List of Scientific Papers published in the Middle East" (pp. 72; Cairo: Unesco Science Co-operation Office, Middle East, November 1949) appeals for the co-operation of all men of science in the Middle East to make the List a really complete bibliography by directing attention to occasional scientific publications, irregular series and books published in the region and assisting in obtaining copies. In principle, this publication contains only original works, or works with original data, of value to scientific workers, and the present number covers the period March 15–October 1, 1949. It is arranged on the same lines as previously: a list of periodicals and serials, arranged by countries, preceding the list of scientific papers arranged by Universal Decimal Classification classes.

Mathematical Periodicals for Yenching University

PROF. E. R. LAPWOOD, of the Department of Mathematics, Yenching University, Peking, writes on behalf of the University asking for help in filling gaps in the library. He asks particularly for sets of the *Proceedings and Journal of the London Mathematical Society* before 1939, and one or two later numbers; also for volumes of the *Mathematical Gazette* before 1920 and various subsequent numbers. Mr. E. Cunningham, 141 Huntingdon Road, Cambridge, acting for the China Christian Universities' Association, would be glad to hear from any who could help to supply these needs.

Botanical Society of the British Isles: Conference

THE Botanical Society of the British Isles is organising a conference on "Aims and Methods in the Study of the Distribution of British Plants", to be held during March 31–April 2 in the lecture room of the Royal Horticultural Society's New Hall, Greycoat Street, Westminster, London, S.W.1. April 2 will be devoted to a field meeting in Quendon Woods, Essex, to study the oxlip (*Primula elatior*). The conference will be preceded by the annual general meeting of the Society on March 30 at 5.30 p.m. in the rooms of the Linnean Society, Burlington House, Piccadilly, London, W.1. All inquiries regarding these meetings should be addressed to the Honorary General Secretary of the Society, c/o Department of Botany, British Museum (Natural History), Cromwell Road, London, S.W.7.

Rheological Problems in Biology

AN international colloquium on rheological problems in biology (see *Nature*, December 24, 1949, p. 1078) will be held in Lund during July 26–28, and sessions will be devoted to general properties of protoplasm, mechanics of muscular contraction, flow of blood, and translocation of nutrients in plants. Since the object of the colloquium is the exchange of ideas between biologists of widely different fields of work, it is desirable that communications should be of a fairly general character and need not deal wholly with recent and unpublished work. Further details can be obtained from: Prof. A. Frey-Wyssling, Pflanzenphysiologisches Institut, Zurich; Dr. G. van Iterson, Baarn, Holland; or Dr. P. Eggleton, Physiology Department, University of Edinburgh.

Summer Schools in Relaxation Methods

SUMMER schools in relaxation methods were held in the Imperial College of Science and Technology, London, during the long vacations in 1945–8, and in the University of Michigan in 1949. Their success has encouraged the provision of similar courses in both Britain and the United States in the coming long vacation, and the programme will cover lectures and practice on the numerical solution of linear algebraic equations, framework problems, Laplace's and Poisson's equations, the biharmonic equation, eigen-value problems, the heat-conduction equation, etc. The course in Britain will be at the Imperial College of Science and Technology, South Kensington, London, S.W.7, during August 29–September 22; the fee will be £5, and further particulars can be obtained from D. N. de G. Allen at the Imperial College. In the United States the course will occupy six weeks in June and July at the Virginia Polytechnic Institute, Blacksburg, Va., and inquiries should be addressed there to Prof. D. H. Pletta.

University of London: Appointments

THE following appointments in the University of London have been announced: Dr. E. K. Rideal, lately director of the Davy Faraday Research Laboratory and Fullerian professor of chemistry in the Royal Institution, to the University chair of chemistry tenable at King's College, from August 1, 1950; Dr. H. J. Eysenck, to the University readership in psychology with special reference to psychiatry tenable at the Institute of Psychiatry, from February 1, 1950.

University of Leeds: Appointments

THE following appointments have recently been made in the University of Leeds: Dr. F. W. Spiers, lecturer in medical physics in the Department of Radiology and Radiotherapy, to the newly instituted chair of medical physics; Dr. N. H. Hartshorne, lecturer in chemical microscopy, to be reader in chemical microscopy; Mrs. Georgiana M. Bonser and Dr. L. L. Dmochowski, lecturers in the Department of Experimental Pathology and Cancer Research, to be readers in cancer research.

University of Sheffield

UNDER the terms of the will of the late Prof. D. Knoop, professor of economics in the University of Sheffield during 1920–48, the residue of his estate was left to the University to be used for the promotion of the study of economics and economic history. With this object in view, the University Council has established Douglas Knoop research fellowships (£425 a year) and the Douglas Knoop research studentships (£300 a year), in economics and economic history. It is hoped that appointments will be made in time for the new Fellows or Students to take up residence in October of this year. The West Riding County Council has made an additional grant of £1,500 a year to the University to further the study of microbiology and in particular towards the chief lectureship in this subject in the University. The title of emeritus professor has been conferred upon Dr. B. M. Laing, who retired from the chair of philosophy at the end of last session. Dr. S. E. Dicker has been appointed lecturer in physiology in the University.

Iron and Steel Institute: Medals and Prizes

THE Iron and Steel Institute has recently awarded the following medals and prizes: *Bessemer Medal* for 1950, to Mr. James Mitchell (honorary treasurer, Stewarts and Lloyds, Ltd.), in recognition of his distinguished contributions to the technical development of the iron and steel industry; *Sir Robert Hadfield Medal* for 1950, to Mr. G. D. Elliot (Appleby-Frodingham Steel Co., Scunthorpe), in recognition of his contributions in practice and theory to the development of blast-furnace operation; A *Carnegie Silver Medal* for 1949, to Mr. N. H. Polakowski (University College, Swansea), for his Andrew Carnegie research report on "The Compression Test in Relation to Cold Rolling"; *Williams Prize* for 1949, jointly to Dr. D. F. Marshall and Mr. H. C. White (Park Gate Iron and Steel Co., Ltd., Rotherham), for their paper on "The Conversion to Oil Firing of the Open-Hearth Furnace at Park Gate Works"; *Ablett Prize* for 1949, jointly to Mr. E. L. Diamond (British Standards Institution; formerly British Iron and Steel Research Association, London) and Mr. A. M. Frankau (British Iron and Steel Research Association, London), for their paper on "Present Methods of Open-Hearth Furnace Charging".

Announcements

WE regret to announce the death on March 18, at the age of sixty-six, of Sir Norman Haworth, F.R.S., lately professor of chemistry and director of the Chemistry Department in the University of Birmingham.

THE title of emeritus professor in the University of Durham has been conferred on Prof. David Burns, recently professor of physiology in King's College, Newcastle upon Tyne (University of Durham).

THE title of emeritus professor in the University of Birmingham has been conferred on Prof. G. Haswell Wilson, formerly professor of pathology, and Prof. L. J. Wills, formerly professor of geology and mineralogy. The following appointments in the University have also been announced: Mr. S. Marchant to be lecturer in geology, and Dr. R. L. Whitmore to be lecturer in coal treatment.

DR. IVOR ISAAC and Mr. G. T. Goodman have been appointed lecturer in botany and assistant lecturer in botany respectively in the University College of Swansea.

THE Surgeon-General of the U.S. Army has announced that it has been decided to discontinue the "Index-Catalogue of the Library of the Surgeon-General's Office".

THE third Conference on the Education of the Young Worker will be held in Magdalen College, Oxford, during August 12–18. The main subject of investigation and discussion will be "The Young Worker in the Job: Initial and Continuing Education". Further information can be obtained from the Director, University Department of Education, 15 Norham Gardens, Oxford.

ERRATUM.—In the communication on the photodegradation of starch by Frank Baker and W. J. Whelan in *Nature* of March 18, p. 449, the wavelength of light used was 2537 A., not 3660 A. as printed.

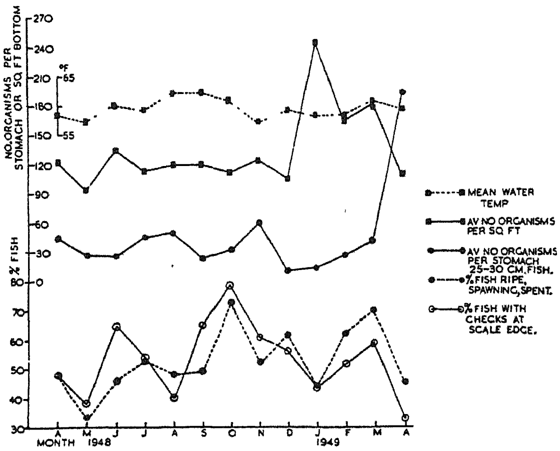
THE 'WINTER CHECK' ON TROUT SCALES IN EAST AFRICA

By Dr. VERNON D. VAN SOMEREN, M.B.E.
River Research and Development Centre, P.O. Nyeri Station, Kenya Colony

VARIOUS factors have been suggested as being the cause of the annual 'winter check' on salmonid scales. Shorter daylight in winter, low water temperatures, lowered food supplies, low temperature causing cessation of feeding, an inherent growth-rhythm, or the onset of maturity have all been supposed by various workers to be responsible for the temporary lowering of growth-rate which is shown as the closer spacing of the scale circuli.

Under experimentally controlled conditions, Bhatia[1] found that the production of periodic zones on rainbow trout scales was dependent neither on an inherent rhythm nor on seasonal temperature changes, but was entirely or primarily dependent on abundant or deficient food supplies. On the other hand, Brown[2], using specific growth-rate as the criterion, found that brown trout of two years old, kept under constant temperature conditions and in the absence of variation of any other environmental factor, showed an annual cycle of growth with an autumn check at two years, rapid growth next spring, slower summer growth, and another autumn check coinciding with the maturation of the gonads at three years old. Hartley[3] has also suggested that, in certain non-salmonid fish, the scale checks which are found mainly in summer are maturity or spawning checks, since these fish spawn in summer, the checks found on the scales of immature fish being doubtless due to some innate physiological rhythm. From his figures there appears to be no relation between percentage of fish showing checks at the scale edge, and the variation in feeding intensity from month to month.

In temperate regions under natural conditions, it is difficult to separate the various possible causes, since in salmonids maturity and spawning are coincident with the season of lowest water temperatures, as well as perhaps a temporary cessation of feeding, although food supplies are not necessarily lowest. In East Africa, on the other hand—in Kenya Colony situated astride the equator—the climate is also temperate between altitudes of 6,000 ft. and 8,000 ft., but is very equable. The only major variation is between wet and dry seasons; the duration of daylight varies by about 30 min. only during the year, and mean river-water temperatures by seldom more than 4° F. from month to month. Bottom food supplies in the rivers vary according to the rainy seasons, being maximal in the low water of the dry January–March season and minimal in the flood season of April–November[4].



In spite of the relative equability of the environment, the rainbow trout, which were first introduced into Kenya rivers some forty years ago, show an annual spawning rhythm, spawning mainly in July–August; although the 'turn-over' is by no means sharp, and immature, spawning or spent fish may be found at any time of the year. Scales from these trout show in most cases well-defined 'winter checks', which are annual in occurrence and can be used for growth-rate calculations[4].

The accompanying graph, which is constructed from the figures in Table 1, shows the relationship

Table 1

	1948									1949				
Month	A.	M.	J.	J.	A.	S.	O.	N.	D.	J.	F.	M.	A.	Total observations
Scale checks														
No of fish	23	13	37	37	20	29	28	46	23	9	21	32	27	345
% fish with checks at scale edge	48	38	65	54	40	65	79	61	56	44	52	59	33	
Fish condition														
No. of fish	23	15	37	38	21	29	29	46	26	9	21	30	29	353
% fish ripe, spawning, spent	48	33	46	53	48	49	73	52	62	44	62	70	45	
Feeding intensity 20·0–30 0 cm. fish														
No. of fish	9	11	29	33	14	20	19	40	18	7	18	25	22	265
Aver. No. of animals per stomach	44	27	27	46	49	24	33	61	11	13	27	41	193	
Bottom food supply														
No. of samples	18	21	21	15	18	24	24	27	27	3	3	3	3	207
Aver. No. of animals per sq. ft.	122	94	136	114	121	121	113	126	106	247	164	183	111	
Water temperature														
No. of observations	60	62	60	62	62	60	62	60	62	62	56	62	60	790
Av. mean temp. (° F.)	58·7	57·4	60·1	59·5	62·4	62·3	61·1	57·2	59·1	58·1	58·4	60·7	59·7	

between the percentage of rod-caught fish in the Sagana River (lat. 0° 22′ S.),[4] which show these checks at the scale edge each month to (*a*) the percentage of fish in each month which were ripe, spawning or spent, (*b*) the feeding intensity of the fish each month, (*c*) the food available in the river each month, and (*d*) the mean monthly water temperatures for the period under study (April 1948–April 1949).

Since the stomachs of rod-caught rainbows in this river are almost always full on capture, it is impossible to estimate feeding intensity by a value for 'fullness'; therefore, the average number of food animals per stomach has been calculated for fish in the 20·0–24·9 cm. group, and for the 25·0–30·0 cm. group. Since the variation in values obtained for the two size-groups is almost identical from month to month, the graph for feeding intensity has been drawn from the results of the two groups combined. The variations shown in monthly feeding intensity, and in food supply available, are due to other causes which will be described elsewhere, and have shown a similar annual cycle for the two and a half years they have been studied. The three peaks in the graph for percentage mature fish are referable to ripe, spent, and spent fish in general.

It is clear from the graph that the percentage occurrence of checks at the scale edge each month is closely correlated with gonad state, r having the significant value of 0·963; there is little doubt that the annual slowing of growth as indicated by the check is due to the maturation of the gonads. The occurrence of the check shows no correlation with the other variable factors of feeding intensity, food available, or water temperature, the calculated values of r in each case having no significance.

As in the leuciscids and cyprinids studied by Hartley (*loc. cit.*), therefore, the salmonid scale check is a maturation mark. Additional support for this has been obtained in a different manner by examining scales from trout trapped while migrating in the river. At this Research Centre, a barrier trap has been erected across the width of the river, which catches all fish moving either up or down. In the 'long rains' season of April–June, whenever the river rises in flood, there is a considerable simultaneous movement of trout up and down the river. It has been found by gonad examination of trapped samples that the trout running up are all ripening or ripe fish; while those moving down are immature, except during July–September, when the downstream catches are largely spent fish.

Table 2

	Upgoing fish		Downgoing fish	
	No.	% with checks at scale edge	No.	% with checks at scale edge
April 1948	50	60	35	23
May	60	72	57	26
June	55	95	20	50

Results of scale analyses of all such fish trapped during April–June 1949 are shown in Table 2. It will be seen that the greater, and increasing, percentage of upgoing fish each month show a check at the scale edge, whereas the greater percentage of downgoing fish show plus growth at the scale edge, except in June, when some may have been spent fish. Some downgoing immature fish would in any event be expected to show checks for reasons explained below. Since both downgoing and upgoing trout would be subject at the time of simultaneous capture to entirely the same water temperatures and food conditions, and the trap merely separates them according to their physiological state, it seems clear again that only their different physiological states can be responsible for the observed differences in the scales of the two series; in fact, that the check is again due to gonad maturation only.

Most Kenya rainbow commence spawning at two years old, but the fact that one-year old fish also show a check indicates some internal rhythm which foreshadows the spawning rhythm of the adult, although the gonads do not necessarily mature fully and the fish is not urged to move upstream. It is interesting, in fact, to note that, as in salmon, many cock rainbows in Kenya will ripen at one year old, enough to express milt at that age; the scales of these small cocks always show a clear one-year check and even severe erosion, whereas one-year hen fish (which do not ripen so readily) or maiden hens of two years old and more show checks which, although present, are not so clearly defined as in the cocks. Scales from maiden hens are not easy to read, the first year often being particularly doubtful.

The width of the check has not yet been examined in relation to the state of the gonads within the series ripening–ripe–spawning–spent. There is probably some relationship between check-width and the actual stage reached in the maturation cycle, and it is possible that many of the fish still showing plus growth in winter in temperate regions are, in fact, late-maturing fish.

A fuller report of this work will be published elsewhere, but in the meantime I am indebted to Mr. H. Copley, fish warden of Kenya Colony, for helpful advice and permission to publish this preliminary note.

[1] Bhatia, D., *J. Exp. Biol.*, **9**, 6 (1932).

[2] Brown, M. E., *J. Exp. Biol.*, **22**, 130 (1946).

[3] Hartley, P. H. T., *Proc. Zool. Soc.*, **117**, 129 (1947).

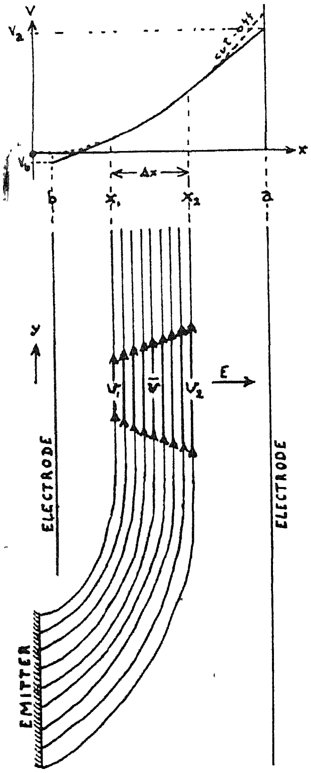
[4] van Someren, V. D. (unpublished results).

GENERATION AND AMPLIFICATION OF WAVES IN DENSE CHARGED BEAMS UNDER CROSSED FIELDS

By DR. O. BUNEMAN
Atomic Energy Research Establishment, Harwell

A STUDY has been made of dense beams of charged particles in crossed electric and magnetic fields, under geometrical conditions rather simpler, yet more general, than in the magnetron (for which a detailed theory exists[1,2]). The mechanism responsible for magnetron oscillations was found to be effective under the new conditions and in no way dependent on the peculiarities and complications of magnetron geometry. The mechanism thus acquires a more fundamental significance and might, tentatively, be added to the list of mechanisms cited as possible explanations of solar noise[3–8].

Oscillations were obtained as the outcome of ordered motion of charge under the external fields and purely long-range Coulomb forces. There is no need to invoke collision phenomena, high temperatures or interaction between charges of two kinds (such as ions and electrons in plasmas). Moreover,



Schematic diagram of beam between electrodes at $x = a$ and $x = b$, coming from emitting surface at $x = 0$. Magnetic field B normal to paper plane. Upper portion showing plot of D.C. voltage V versus x and (broken) cut-off parabola $eV = 2\pi^2 m f_0^2 x^2$. Beam edges x_1 and x_2 given by $x_1 = b + \sqrt{(b^2 - eV_b/2\pi^2 m f_0^2)}$ and $x_2 = a - \sqrt{(a^2 - eV_a/2\pi^2 m f_0^2)}$

the process is purely electrostatic (the velocity of light does not enter) and can occur at low fields and low frequencies.

In crossed fields (B in the z-direction, E in the x-direction, see diagram) charges can move in the y-direction at uniform velocity $v = E/B$. In general, there will be periodic deviations from this uniform drift, but these we shall treat as perturbations later. In heavy beams, E cannot remain constant across the beam and v will therefore vary over a range Δv about a mean value $\bar v$ from one beam edge to the other. If all charges originate from a common emitter at $x = 0$, absence of longitudinal fields leads to $v = 2\pi f_0 x$, where f_0 is the cyclotron frequency $eB/2\pi m$ (2·8 Mc. per gauss for electrons). The D.C. potential relative to the emitter then follows the cut-off parabola $V = 2\pi^2(m/e)f_0^2x^2$ ($= 1\cdot12 \times 10^{-14} f_0^2 x^2$ for electrons, using volts, cm. and sec.) across the beam and tangents to this parabola outside (see upper part of diagram). For given positions and potentials of the electrodes between which the beam travels, one can then calculate the positions of the beam edges and the velocity interval. The beam density is $\varepsilon e B^2/m$ (from which it follows that the 'plasma frequency' is f_0 throughout—in the cylindrical magnetron it varies) and the beam current $4\pi^2\varepsilon(m/e)\bar v \Delta v f_0$ per unit width in the z-direction ($= 2 \times 10^{-27} \bar v \Delta v f_0$ for electrons, using amp., cm. and sec.). This is the current accepted by the space between the electrodes.

The beam so constructed corresponds to the 'Brillouin steady state' in magnetrons. It is perhaps slightly artificial in concept, because no transverse motion is admitted; but it is self-consistent and represents a convenient state for the application of perturbation methods.

Allowing, in the first place, only transverse perturbations of the beam shape which do not change with time, one finds non-interpenetrating orbits which resemble trochoids (for zero density the beams are, of course, trochoidal). As perturbations are additive, we may say that the further perturbations discussed below apply to these quasi-trochoidal beams as well as to the original straight one. However, the streams being non-interpenetrating, it would be rash to generalize the results to looping trochoids.

Perturbations in time were found to be propagated along the beam with a phase velocity somewhere within the range of the particle velocities. Even between close plates, frequencies far below electromagnetic cut-off can be propagated, the beam acting as a sort of dielectric loading. The frequency f must be of the same order of magnitude as f_0 but need not be identical with it. For a narrow velocity-band, namely, when $\Delta v/\bar v$ is rather less than $\frac{1}{2} f_0/f$, the wave-velocity is actually $\bar v$. As the particle-velocity band-width increases, the wave velocity can adopt two possible values which eventually tend to $(\bar v \pm \frac{1}{2}\Delta v)/(1 \pm 0\cdot54\, f_0/f)$. These final wave-velocity values apply with fair accuracy provided they turn out to be less than about $\frac{1}{2} f \Delta v/f_0$. The figure 0·54 in the formula is the result of some elaborate calculations. The intermediate case between 'narrow' and 'wide' velocity-bands is too complicated to present in a brief summary.

If a given frequency is injected into the system at one point along the beam, the above expressions for the wave-velocity determine the wave-length λ with which the periodic disturbances spread along the beam. They will be amplified downstream, the power increase in decibels per cycle being $27\cdot3\,\Delta v/\bar v$ in the case of the narrow velocity-band and $3\cdot4 f_0/(f \pm 0\cdot54 f_0)$ in the two wide-band cases, provided external losses are negligible.

If, on the other hand, the wave-length is fixed by external geometry, for example, by linking one end of the beam to the other through an external circuit or by bending the geometry into a re-entrant one as in magnetrons (and locking the beam to a definite mode of a set of resonators), the above expressions for the wave velocity, λf, determine the frequency f. *The amplitude will then increase spontaneously with time*, the power-increase in decibels per cycle being $27\cdot3\,\Delta v/\bar v$ (as above) in the case of the narrow velocity-band and $3\cdot4 f_0/f$ in the two cases of the wide velocity-band.

The oscillating fields die off like $\exp(\pm 2\pi x/\lambda)$ on either side of the beam, and the numerical results quoted will have to be modified when there is less than about half a wave-length space between beam edge and electrode, as on the cathode side of the magnetron. The induced magnetic field is in the z-direction (like the applied field). The longitudinal electric field changes phase across the beam by about $\frac{1}{2}\pi$ for narrow bands, decreasing as the band-width increases. The phase change of the transverse electric field and the magnetic field, correspondingly, is $-\frac{1}{2}\pi$, tending towards $-\pi$.

The transfer of energy from the D.C. fields to the oscillating fields depends on the particles successfully breaking through the magnetic barrier and eventually reaching an electrode. In the planar geometry there does not exist a threshold condition similar to that which I derived for cylindrical magnetrons[9]. But one can make efficiency estimates on a similar basis and find that efficiencies of the order of 50 per cent or higher are possible.

There are some resemblances between the results presented here and Haeff's[10]. But there are two essential differences: Haeff's analysis implies an infinitely strong longitudinal magnetic field, thus eliminating transverse motion, whereas here we have a finite transverse magnetic field and take into account transverse motion; also there is lateral staggering of streams of different velocities and a continuous velocity spectrum in the present case, whereas Haeff assumes discrete velocities of superimposed beams.

In so far as the interaction of streams with different velocities is at play in beams under crossed fields, Haeff's[10] speculation as to the cause of magnetron phenomena is superficially correct. The detailed theory in explanation of these phenomena had, of course, been worked out in 1944 (refs. 1 and 2).

As a means of generating or amplifying microwaves, the device investigated (plane electrodes, no resonators or corrugations) is attractively simple. How far the system is representative of conditions on the sun's surface remains to be looked into.

Acknowledgment is made to the Director of the Atomic Energy Research Establishment for giving permission for the publication of this note.

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POPULATION OSCILLATIONS CAUSED BY COMPETITION FOR FOOD

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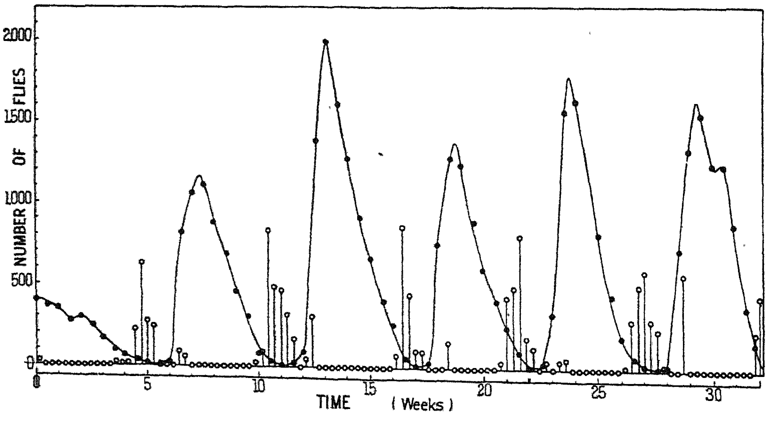
FROM a study of larval competition it was concluded[1] that populations of *Lucilia cuprina* should oscillate continuously in a constant environment. This conclusion has now been confirmed by experiments which will be described fully elsewhere. It is illustrated by the accompanying graph, which is based on a culture of flies kept at a constant temperature of 25° C. Fifty grams of meat was supplied every second day, and ample fresh water and dry sugar for the adults were always present in the cage. The sinuate line records the fluctuation of the adult population with time, while the small circles and vertical lines represent the number of flies (if any) that developed from the meat exposed on the day indicated, these flies contributing to the adult population in the cage about two weeks later.



The graph shows that, except when the population is increasing rapidly and so consists mainly of immature flies, no adult offspring are produced when the number of flies exceeds about 300; but many are produced at appreciably lower numbers, with a maximum when the parents approximate to 50.

This broadly inverse relation between the numbers of parents and of adult offspring represents a density-dependent reaction which would maintain a stable population if it operated promptly. But, because reaction remains latent until the larvæ have developed into egg-laying flies, it does not oppose initiation of further reaction in the same direction for a period of about two weeks. Consequently, there is a gross overshooting of the equilibrium position, which leads in turn to a subsequent overshooting in the opposite direction; and so cycles of increase and subsequent decrease in abundance continue indefinitely. To be more explicit, the larvæ produced by small numbers of flies find adequate food and so can metamorphose, thus producing large numbers of adults; these lay so many eggs that all food is eaten before any of the developing larvæ are big enough to metamorphose successfully; then, there being no new accessions, the adult population progressively diminishes until it is once more small, when the cycle begins again.

Oscillations similar to those in the graph were obtained in several other such experiments in which adults and larvæ had access to the same meat. Analysis showed that competition was almost completely confined to the larvæ, for even at the highest densities the flies obtained sufficient protein to develop their eggs.

In another series of experiments, competition for food was confined to the adults. These were regularly given a separate small supply of protein, and were excluded from the larval food, which was maintained in excess at all times. As with larval competition, violent oscillations in adult density were produced.

In these experiments it was found that the number of eggs laid fell progressively to zero as adult density increased above a certain level. There must be, therefore, a steady density at which the number of eggs laid balances mortality; but this was not attained in the experiments for, even when the density of flies was much below it, the offspring produced greatly exceeded the steady density. These, in turn, laid few or no eggs because the flies were so numerous that few, if any, obtained sufficient food for egg development. The observed oscillations were due to the lag and to the violence of these density-dependent reactions.

With populations of yeasts and of certain Protozoa[2], the reproductive-rate also falls with increasing density; but these micro-organisms, by budding or fission, produce offspring that immediately compete for food with the mature individuals. There being no significant delay in the operation of reaction, there is no tendency to overshoot the steady density, which is therefore approached asymptotically.

As animals higher than the Protozoa usually produce many offspring even when on the verge of starvation, and as their offspring begin to compete for food significantly only after the lapse of some time, their populations might be expected to oscillate like those of *Lucilia* rather than to grow logistically like yeast populations. The fact that they have not previously been recorded as doing so is only partly due to the paucity of appropriate experiments; for, as the following discussion shows, food limitation may produce other effects, and other kinds of factors may supplement or completely replace competition for food as the dominant controlling agency[3].

Populations of animals with low rates of reproduction may not be inherently oscillatory when controlled by competition for food, for there is evidence[1] that, if *Lucilia* had a power of increase of less than twice per generation, its population would approach the steady density asymptotically. Data obtained in the *Lucilia* experiments also indicated that if larval and adult competition for food operate together, increasing larval mortality, combined with falling fecundity with increasing density, may so check multiplication that little or no overshooting of the steady density occurs. According to the relative intensities of the two kinds of competition, sustained oscillation of reduced amplitude, damped oscillation, or asymptotic population-growth would be produced. It is suggested that such interference between the two oscillation systems caused the stability of the *Drosophila* populations studied by L'Heritier and Teissier[4], for the high larval mortality they record indicates both direct control by food and a high reproductive-rate that otherwise would cause oscillation.

The prompt destruction of starvation-weakened surplus animals by inimical environmental factors can prevent oscillation and limit the population a little below the maximum density permitted by the available food. Predators that cannot readily attack vigorous prey may exercise such control, their own populations then being limited at a level indirectly determined by the food supply of their prey.

When healthy prey are readily attacked by predators, it is the space-property of the food, not nutriment, that is decisive. Thus entomophagous parasites search over the surface of food plants for their hosts, and make these so scarce that barely sufficient can be found by the parasites to maintain their own numbers. The densities of parasites and hosts oscillate both in space and in time, the general level of the hosts being held far below that permitted by available nutriment[5].

Density-dependent reaction to the space-property of food is also dominant in the control of populations of those stored-product insects that have been studied experimentally. Frequency of contact is the critical factor, fecundity falling and egg-destruction increasing with density[6,9]. The fact that near-constant adult populations were obtained in some experiments[7] with *Tribolium*, whereas in others there was marked oscillation[8], is presumably due to fecundity and mortality being affected by population-density in different relative degrees in the experiments (cf. *Lucilia* and *Drosophila*). The oscillations of various amplitudes observed in populations of *Trogoderma*[8], *Gnathoceros*[8], and *Callosobruchus*[9] appear to have a similar underlying cause.

Behaviour reactions of animals may also profoundly affect populations. Thus intra-specific strife induced by dearth of food or of favoured situations, and often accentuated by the territory habit, causes the death of the weaker animals or prevents these from successfully rearing offspring[10], so tending to stabilize populations; whereas mass migration induced by high densities, as with locusts, causes violent long-period oscillations.

Occasionally change in the physical environment is dependent on density. Thus crowding of *Rhizopertha*[11] causes the infested grain to reach a barely tolerable temperature, so limiting reproduction to the replacement-rate; and *Daphnia*[12] populations oscillate because of delayed effects of oxygen depletion or of the accumulation of metabolites.

It is evident from this discussion that populations do not conform to any single pattern, such as the logistic curve; but there is a single dominant controlling mechanism, namely, density-dependent reaction. This governs the general levels of populations, usually in some relation to the availability of food; and it produces stability or oscillation mainly according to the degree of delay between the initiation of reaction and its effective operation.

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NEW SOUTH WALES UNIVERSITY OF TECHNOLOGY

THE laying of the foundation stone of the New South Wales University of Technology at Kensington, near Sydney, took place on Saturday, February 25. In brilliant sunshine, representatives of the Australian universities, accompanied by distinguished visitors, walked in academic procession to the dais, where the foundation stone was set by the Governor of New South Wales, Lieutenant-General John Northcott. The premier of New South Wales, the Hon. J. McGirr, unveiled a tablet commemorating the incorporation of the University by Act of Parliament. The Minister for Education, the Hon. R. J. Heffron, who had been closely associated with the development of the N.S.W. University of Technology since its inception in 1947, also took part in the ceremony.

More than one thousand people attended the ceremony; among the distinguished guests present were Lord Nuffield, ministers and members of both Federal and State Parliaments (the Prime Minister being represented by the Hon. E. J. Harrison, Minister for Defence), the Deputy Premier of New South Wales, the Hon. J. J. Cahill, Minister of Public Works, the High Commissioner for the United Kingdom, a number of other consular representatives and many senior executives and managers of industrial and commercial organisations. Among the university representatives present were Sir Charles Blackburn, chancellor, and Mr. Justice E. D. Roper, deputy chancellor, of the University of Sydney, and Prof. R. C. Mills, chairman of the Interim Council of the Australian National University, Canberra, Sir John Medley, vice-chancellor of the University of Melbourne, Prof. D. B. Copland, vice-chancellor of the Australian National University, Canberra, Prof. G. A. Currie, vice-chancellor of the University of Western Australia, Prof. S. H. Roberts, vice-chancellor of the University of Sydney, Prof. J. J. Stable, president of the Professorial Board, University of Queensland, and Prof. T. Hytten, vice-chancellor of the University of Tasmania.

The president of the University, Wallace C. Wurth, announced three grants made to assist the work of the University. Lord Nuffield had provided, through the Nuffield Foundation, a Nuffield research professorship for mechanical engineering from a grant totalling £25,000 sterling over ten years. Such a research professorship in mechanical engineering is unique in the British Commonwealth, and this is the first occasion on which the Nuffield Trust has endowed a research professorship outside the British Isles. A sum of £15,000 has been provided by the mining companies at Broken Hill towards the provision of senior staff in mining engineering. The Commonwealth Government has approved the allocation of £20,000 over two years to assist the University in research work.

When laying the foundation stone, H.E. the Governor made special reference to the fact that, whereas in the past Britain has shown a lead to the Dominions in most matters, in the establishment of the first university of technology in the British Commonwealth, New South Wales has not only given a lead to the other Australian States, but also to the mother country. This is most appropriate in view of the increasing industrial development of Australia and the status that country now has in the affairs of the British Commonwealth.

An interesting feature of the proceedings was the delivery in turn by vice-chancellors of the Australian universities of messages of greeting to the new University. Mr. A. Denning, director of the University, read a number of messages which had been received from leading world universities and technological institutions overseas. These included greetings from President Killian, of the Massachusetts Institute of Technology in the United States; President Pallmann, of the Zurich Institute of Technology; Sir Edward Appleton, vice-chancellor of the University of Edinburgh; Sir Raymond Priestley, vice-chancellor of the University of Birmingham; Dr. David S. Anderson, director of the Royal Technical College, Glasgow; Prof. O. A. Saunders, professor of mechanical engineering in the Imperial College of Science and Technology, University of London; and Prof. Eric Ashby, vice-chancellor elect, University of Belfast. Messages were also received from Lord Eustace Percy, rector of King's College, University of Durham, and Mr. L. B. Robinson, managing director of the Zinc Corporation Group of industries, London. A personal message was read from Prof. M. L. Oliphant, Poynting professor of physics in the University of Birmingham, who will go to Australia in 1951 as director of the Research School in Physics of the Australian National University. After pledging his co-operation with the N.S.W. University of Technology, he stated that the occasion of the laying of the foundation stone of this institution was an event which may mark the beginning of a revolution in technical education in the British Commonwealth.

BRITISH COUNCIL

REPORT FOR 1948–49

It will be recalled that on the opening day of the 1948 Conference of the Universities of Great Britain and Northern Ireland on December 17, 1948, there was some discussion of three resolutions concerned with encouraging the interchange both of young postgraduates and of teachers which had been passed at the Congress of Universities of the Commonwealth in the previous July; Mr. J. F. Foster, secretary of the Association of Universities of the British Commonwealth, had referred to the setting aside by the British Council of a definite sum for travel grants, to be administered by a joint committee of the Committee of Vice-Chancellors and Principals, of the Association of Universities of the British Commonwealth and of the Universities Advisory Committee of the British Council. Later in the discussion, Dr. A. E. Morgan explained briefly how the British Council came into this scheme, which was only a small beginning towards the great Imperial academic travel fund which was really required. For the academic year 1949–50 there would only be available from the British Council a sum of £6,000, obtained by reducing its awards of postgraduate scholarships from nineteen to eight, though Dr. Morgan hoped that this sum might be supplemented by funds from other sources.

The Council's own report for 1948–49* briefly records this development as starting in March 1949, but the analysis of expenditure included is for the year 1947–48, in which £12,136 is shown for travel costs of interchange of university staffs between Commonwealth and other overseas countries and the United Kingdom and £201,844 for scholarships and bursaries generally. Other items of expenditure which may be noted in passing are £34,124 for the work of the Council in general science, agriculture and medicine, £160,512 for books, book exhibitions, British Council publications and overseas press, and £67,730 for the purchase and distribution to Council libraries and other institutions of technical and other periodicals. During 1948–49, the Council awarded 242 new scholarships as compared with 272 in the previous year, and 119 of the latter holders continued during part or the whole of the second year. During 1948–49, sixty-two foreign scholarships for British students were offered by twelve countries through the Council, as compared with thirty-six in 1947–48. The short-term bursary scheme, designed mainly to enable industrial or social workers, technicians, local government officers, etc., to live in Great Britain for three to six months and pursue their normal occupations, developed considerably, and awards were made to 105 bursars from forty countries.

During the year, thirty-two summer schools were held in twenty-two countries overseas, attended by more than 1,600 persons, while summer schools at seven British universities were attended by a further 1,742. Besides this, vacation courses were arranged for overseas students at universities in the United Kingdom, and the Council also provided a special 'introduction course' for Council scholars on their arrival in Great Britain from countries where living conditions are widely different. The value of this student welfare work of the British Council has been since signally recognized by the Colonial Office, which from the beginning of 1950 has transferred to the British Council the formal responsibility for the welfare of all Colonial students in Great Britain. The Council will now be responsible for housing two hundred such students in new London hostels as well as for the Colonial Office hostels in the provinces, and for this it will be provided with an additional £515,000 from the Foreign Office, Colonial Office and Commonwealth Relations Office, of which £425,000 will come from the Colonial Development and Welfare Fund, and which will be managed by the Council as a separate account.

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* British Council. Report for 1948–1949. Pp .147. (London : British Council, 1949.)

To other activities of the British Council the general cut of ten per cent imposed on all Government expenditure will in future apply, and the accounts of the work given in the latest report will be read with that limitation in mind. Glancing first at the work under the Science Advisory Committee, of which Sir Henry Dale has resigned the chairmanship after serving since 1942, the Engineering Panel of Advisers has been replaced by the secretaries of the Institutions of Civil, Mechanical and Electrical Engineers, and their presidents serve on the Science Advisory Committee. A Combined Sciences Department has taken over the responsibility of work for all sciences other than agriculture and medicine. Lecture tours overseas were undertaken by twenty-one eminent British men of science, and a conspectus of current scientific research in British universities and university colleges was prepared under the title "Scientific Research in Britain". A survey was made of financial facilities available in the United Kingdom to enable British scientific workers to study overseas and vice versa. In the Science Library 134 bibliographies were compiled in response to requests, and these are distributed to all Council libraries overseas.

The library of the Medical Department dealt with more than 140 requests for bibliographies and information, and more than fifty scholarships were awarded to medical postgraduates and places found for them in universities and hospitals. At the request of the Ministry of Health, programmes were arranged for World Health Organisation fellows studying in Great Britain. The showing of some films on anæsthesia to Italian medical men led to the dispatch of Mr. Geoffrey Organe, of the Westminster Hospital, to Italy and to the establishment there of three schools of anæsthesia; it is somewhat surprising that such results and the close relation between the medical profession in the two countries should have been left to the initiative of the British Council. A similar remark, apart from the question of travel funds, might well be made of the initiation of interchange of lecturers between British and foreign universities. It seems highly desirable that universities and professional institutions should scrutinize carefully this latest report of the British Council and decide what activities there may be which it would be more fitting with professional esteem for them to pursue on their own initiative, and what it is more appropriate to leave to the British Council because of the greater experience which, as in student welfare, the latter is able to bring to bear.

This may well be true of some publishing activities. To *British Science News* (ceased publication, 1950) and the *British Medical Bulletin*, the new quarterly *British Agricultural Bulletin* was added in 1948; but there are other publishing activities, such as *Britain To-day*, which might be improved with closer scrutiny, and the book trade should now be able to manage its own exhibitions of books overseas and export trade without specific assistance from the Council. The library policy of the Council has already changed, and responsibility for the establishment or maintenance of general public libraries is being transferred to the Colonies themselves. The report points out that the main impact of the work overseas is upon specialists, students and others who are unable to visit Britain, and that about half the Council's headquarters staff is engaged in providing the necessary services and supplies of cultural material for the overseas staff.

EARTHQUAKES DURING OCTOBER–DECEMBER 1949

DURING the last three months of 1949 there were thirty-one strong earthquakes and at least 116 minor ones. October opened with a shock having an epicentre to the west of Lake Tanganyika. On October 4 there was a shock of magnitude 6¼, from latitude 1° S., longitude 21° W., in mid-Atlantic; but probably the greatest earthquakes of the month were on October 19, 20 and 21 in the Solomon Islands region. The epicentre of these shocks was near lat. 5½° S., long. 154° E., and the magnitude of the greatest 7¼. As far away from the epicentre as Rabaul (New Britain), damage was done to some houses which were thrown off their foundations, while in other houses crockery and glassware were damaged by being thrown from tables and shelves. Several water tanks were thrown from their stands. On October 31 a shock of magnitude 6¾ occurred some seventy miles south of Sitka (Alaska), and this was felt in Sitka. Probably the earthquake of deepest focus during the three months, however, happened on October 28 in the region of the Fiji Islands, the depth being about 450 km.

On November 22, in the region of the Kermadec Islands, the greatest earthquake of that month occurred, and the next greatest, on November 27, was in the region of the Tonga Islands; the former had instrumental magnitude 7½ and the latter 7¼. It is possible that a slight earth tremor occurred on November 16 in the Potteries district in England. Windows rattled and beds moved, but no damage has been reported.

December 17 and 19 marked the principal earthquakes of that month. On December 17 there were many shocks having the same epicentre (lat. 54° S., long. 71° W.), the greatest being at 15h. 07m. 53s. G.M.T., this having instrumental magnitude 7½. The region affected was in the far south of the Argentine and Chile, and the movement was particularly severe in Tierra del Fuego. Property damage was done at Punta Arenas (Chile), the most southerly town in the world, where several buildings, including a school, collapsed. At the small Argentinian seaport of Ushuaia, the pier broke in two and several buildings were damaged. The total casualties appear to have been one policeman killed and another injured when a house collapsed. On December 29 an earthquake with instrumental magnitude 7·4 shook Luzon, the chief island of the Philippines. Near Ilagen, the capital of Isabella Province, on the east coast fissures spouted water and roads were blocked by landslides. At Naguilian, near by, a 'jeep' is said to have disappeared into a fissure. Along the coast, there were landslides and the sea ran over low-lying country, drowning one woman. In Manila and other places damage was done to buildings, and in Cabantuan several women and children were injured in a panic rush from a cinema. Records have been received from the central stations at Strasbourg and of the United States Coast and Geodetic Survey, and from individual stations at Cleveland (Ohio), De Bilt (Netherlands), Durham, Kew, Pasadena, Stuttgart, Toledo, Zurich and the Swiss observatories.

DEVIATION OF RADIO WAVES AT THE IONOSPHERE

INVESTIGATIONS in radio direction-finding have been conducted in Great Britain under the auspices of the Department of Scientific and Industrial Research since the formation of the Radio Research Board in 1920. This work has had a two-fold objective: first, to ascertain the possibilities of direction-finding at various frequencies for practical application to such purposes as station identification, navigation and meteorology; and secondly, to explore the phenomena involved in the propagation of radio waves over the surface of the earth and through the upper and lower atmosphere. The research towards these objectives has entailed a continuous improvement in instrumental technique, the results of which have had a far-reaching influence on the development and use of radio direction-finding equipment all over the world. In the high-frequency range of about 3–30 Mc./s., radio waves are transmitted mainly as a result of one or more reflexions from the ionosphere; and unless precautions are taken to avoid them, errors in the indication of the direction-finders result from the reception of waves coming down from the ionosphere under certain conditions of polarization.

Such instrumental errors are, however, reduced to a negligible magnitude in the spaced-loop type of direction-finder, which was developed as a practical tool in Great Britain more than ten years ago. With suitable equipment of the spaced-loop type the actual azimuth of arrival of radio waves can be determined to within a fraction of a degree. But this may not be the correct bearing of the sending station unless the propagation of the waves has been confined to the great-circle plane containing both sending and receiving stations. The results of experimental investigations on this problem carried out during 1938–47 are described in a recent report[*] from the Department of Scientific and Industrial Research, entitled "Lateral Deviation of Radio Waves Reflected at the Ionosphere", by W. Ross.

The investigations included large numbers of observations of the direction of arrival of waves from various transmitting stations at distances ranging from 90 to 8,500 km. The deviations from the great-circle path were found to be of a random and variable nature; at distances less than about 300 km., the rapid moment-to-moment fluctuations were superimposed upon slowly varying deviations with quasi-periods of 10–30 min. The standard deviations of the observed departures from the true bearing of the sending station ranged from about 8° for a distance of 90 km. to 3° for a distance of transmission of 260 km. These figures are mutually consistent, and suggest that the cause lies in a random tilting of the $F2$ layer of the ionosphere, the standard deviation of the tilt being about 1–1·5°. For ranges of transmission beyond 500 km. the fluctuations, although still very marked, decrease in magnitude. Typical values for the standard deviation of the fluctuations ranged from 0·9° to 1·3° for distances of 500–5,000 km.

At the close of the Second World War an opportunity arose of comparing the bearing deviations obtained in the above manner with a spaced-loop direction-finder of small aerial spacing (a tenth of a wave-length) with observations taken on a different system, which had been developed by the Germans, and using an aerial spacing of about two wave-lengths. For comparable conditions the close agreement in the results obtained supports the conclusion that the fluctuations in observed bearings are due to a tilting or corrugation of the ionosphere at the point where the waves are reflected from it. The extent of these tilts is not known; but the experiments suggest that they may be measured in tens of kilometres. The study of the lateral deviation of radio waves propagated by way of the ionosphere has been greatly extended in the present programme of work at the Radio Research Station, Slough, as a result of these investigations.

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[*] Department of Scientific and Industrial Research: Radio Research. Special Report No. 19: Lateral Deviation of Radio Waves Reflected at the Ionosphere. By W. Ross. Pp. iv+32. (London: H. M. Stationery Office, 1949.) 9*d.* net.

DAYTIME METEOR STREAMS OF 1948

TWO papers, under the title "The Daytime Meteor Streams of 1948", the first by A. Aspinall, J. A. Clegg and A. C. B. Lovell, and the second by C. D. Ellyett, have recently been published (*Mon. Not. Roy. Astro. Soc.*, 109, 3; 1949). The first paper deals with the measurement of the activity and radiant positions of the daylight meteor streams between May and August, 1948, which were first studied by the radio-echo method in 1947. The results of the 1948 work confirm those of the previous year and also provide some additional information, in particular on four other major showers in July and early August. The radiants of these were at $\alpha = 85^\circ$, $\delta = +11^\circ$, $\alpha = 96^\circ$, $\delta = +21^\circ$, $\alpha = 108^\circ$, $\delta = +13^\circ$, each of which gave echo-rates of 20–35 per hour, and remained active between July 12 and 17, after which their activity remained at a low level. The other shower became active on July 23 and reached its peak two days later, when its hourly rate rose to 30 per hour. The radiant was rather diffuse, in Auriga, varying from 80° + 39° on July 23 to 91° + 38° on August 4, after which it disappeared. Numerous tables, charts and details on individual showers are given in the paper, which should be carefully studied by everyone interested in meteor work.

The second paper is concerned with the measurements of velocities of meteors associated with the showers described in the previous paper. The automatic recorder gives a photographic record of the range and individual amplitudes of the first sixty pulses reflected from the meteor trail[1]. The mean velocity for ten Geminid meteors was found to be 34·4 ± 1·45 km./sec., which is in good agreement with Whipple's photographic results[2]. From the geocentric velocities thus determined, it is possible to deduce approximate results for the heliocentric velocities, and up to the present these confirm elliptic orbits—a view which is now practically accepted for most, if not all, meteor streams.

[1] For reference to the apparatus, see *Nature*, **161**, 596 (1948).

[2] *Proc. Amer. Phil. Soc.*, **79**, 499 (1938).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

A Fundamental Property of Atmospheric Circulation

Five or six years ago, in reports to the Meteorological Research Committee, I analysed the air-mass transport in vertical cross-sections of the circulations between cyclones and anticyclones[1]. One of the results reached was that the horizontal air-mass transport (ρv) reaches a maximum, not at the tropopause, but rather lower, often at about the 8-km. level. This level, indeed, seems to be the boundary between two circulations in the vertical plane; the lower circulation involves upward motion in the cyclone, thence horizontal transfer towards the anticyclone, thence subsidence in the anticyclone; the upper circulation involves subsidence in the cyclone, including subsidence in the stratosphere, thence horizontal transfer towards the anticyclone, thence ascent of air, both in the upper part of the troposphere and in the stratosphere of the anticyclone. The influence of such circulations in causing variations in the height of the tropopause was discussed.

This characteristic of the movements of the atmosphere, coupled with the long-known fact that 8 km. is approximately the level of quasi-constant air-density over the globe, suggests that it is coupled with some fundamental property of the atmosphere.

On consideration, it is, of course, obvious that with the continued attenuation of the atmosphere with height, ρv cannot increase indefinitely with height. Does it therefore tend to be a maximum at some characteristic level? Since the force producing air movement is the horizontal pressure gradient Δp, and since in geostrophic balance ρv is proportional to Δp, the problem is one of determining the variation of Δp with height when different parts of the atmosphere of the globe are unequally heated.

The matter can be explored dynamically. Consider two columns of atmosphere, A and B, which differ in temperature. In A, for two pressure-levels p and $p + \delta p$ separated by a vertical distance δz, we have:

$$\delta z = -\frac{\delta p}{g\rho} \text{ or } -\frac{R\theta}{g} \cdot \frac{\delta p}{p},$$

where ρ and θ are the density and temperature at level p. Similarly in B, for the same two pressure-levels we have,

$$\delta z' = -\frac{R\theta'}{g}\frac{\delta p}{p}.$$

If A and B have the same pressure at ground-level, then the total stretch of B as compared with A, up to level p, is

$$-\frac{R}{g}\int(\theta' - \theta)\,\frac{dp}{p},$$

the integration being taken from ground-level (p_0) up to level p.

The corresponding horizontal pressure-difference Δp at a given height is given by

$$\Delta p = R\rho\int(\theta' - \theta)\,\frac{dp}{p}.$$

If the numerical values of θ, θ' against height or pressure are known, the integral can be evaluated step by step. But since the lapse-rate of temperature is much the same in the troposphere all over the globe, we can get an approximation to the average conditions by taking $\theta' - \theta$ as constant. The integral then becomes

$$\Delta p = R\rho\,(\theta' - \theta)\log_e\frac{p_0}{p}.$$

The value of p for which Δp is a maximum can be determined directly in two simple cases: (1) the atmosphere isothermal, where $\rho \propto p$, and (2) the atmosphere in adiabatic equilibrium, where $p = k\rho^{\gamma}$. In the first case, the maximum is reached when $p = p_0/e$, giving $p = 370$ mb., which corresponds to a height of just under 8 km. In the second case the maximum is reached when $p = p_0/e^{\gamma}$, giving $p = 250$ mb., or a height of about $10\frac{1}{2}$ km.

Cases where large-scale or global circulation is involved should usually lie between these two extremes.

If two air-masses have initially a substantially greater temperature difference at low levels than at high levels, the height of maximum air-mass transport is lowered; this condition applies specially in the initial stages of development of depressions.

The opposite case—of a temperature-difference increasing substantially with height and thus pushing the level of maximum ρv beyond about $10\frac{1}{2}$ km.—is less easy to visualize, but might occur, for reasons which cannot be detailed here, in the tropics, where insolation is nearly vertical.

The 'jet stream' with its axis between the levels theoretically computed above can be seen as the extreme case of a sharp maximum of ρv. Except in the case of jet streams, ρv does not usually reach a very sharp maximum, the curve rising gradually with height to a hump with maximum between 7 and 11 km.

Various questions now suggest themselves. Whenever differences of temperature arise, as, for example, through the different amounts of insolation in different latitudes, will this tendency for horizontal mass-transport of air to reach a maximum about the 8–10 km. level lead in general to the creation of two circulations, one below and the other above this level, running in opposite senses as if geared into one another? A simple extension of the calculation given above shows that the slope of the isosteric surfaces between A and B changes sign at this level with respect to horizontal surfaces but not with respect to the isobaric surfaces, as it would require to do (on Bjerknes's Circulation Theorem) to provide the force needed to create a secondary circulation in the reversed sense at higher levels. Since in the atmosphere the distribution of density at higher levels in these cases is normally, in fact, such as to favour the secondary circulation in the reverse sense, it seems that the density change in higher levels is itself probably a result of the primary circulation. (For example, Palmen and Nagler[2] have recently shown that this reversed upper secondary circulation is a characteristic of 'jet streams'.)

Further, has this characteristic in the redistribution of mass an essential influence in limiting the height of that region of the atmosphere which attains convective equilibrium (that is, the troposphere) and in producing the conditions of the upper layer (the stratosphere) ?

This note is communicated with the permission of the director of the Meteorological Office.

A. H. R. Goldie

Meteorological Office,
London, W.C.2.
Jan. 27.

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[1] A summary is given in the November and December 1949 issues of *Weather*.

[2] *J. Meteorology*, 6, No. 4 (1949).

X-Ray Diffraction Pattern given by Bacterial Flagella

A preliminary report has already been given[1] on an X-ray diffraction study of bacterial flagella. The X-ray work was carried out in the Department of Biomolecular Structure of the University of Leeds, on flagellar preparations obtained from Uppsala. However, it has since proved useful to carry out some further X-ray work on the spot at Uppsala, and the following is a summary of the results so obtained.

The photographs were taken with copper $K\alpha$ radiation from a Philips tube running at 40 kV. and 18 m.amp. The specimen-to-film distance was about 36 mm., or 105 mm. for the long spacings. The X-ray beam in the latter case had a divergence of 25′, permitting the measurement of spacings up to about 150 A.

The specimens used previously have been films made by drying pools of flagellar solutions on glass slides, and pseudo-fibre diagrams have been obtained. It has now been found possible to prepare actual fibres by rolling a thick flagellar paste between ground-glass plates. No difference has been observed in the diagrams at large angles ; but the fibre diagrams show a sharp reflexion at 40 A. which is not seen in the film diagrams. Possibly, therefore, there is a somewhat different packing of the flagella in the two cases, or the stress applied while forming the fibres brings about some slight modification of the flagellar structure.

X-ray studies of wet and dry hæmoglobin[2] indicate that the molecules of this protein are anhydrous invariant units, with the water of hydration lying between. Bacterial flagella are very hygroscopic indeed, exposure for one or two days of a dry preparation to saturated humidity being sufficient to change it from a horny brittle mass to a thick glue. An X-ray comparison between a dry and wet specimen can be made by enclosing a flagellar fibre in a thin-walled glass capillary (giving only faint diffuse scattering) and sealing the capillary with water. In this way it has been shown that the wetting process alters the spacings, ranging from 4 to 40 A., by only a few per cent at the most. Here also, then, a comparatively anhydrous invariant unit is suggested. A marked effect of the wetting is, however, a sharpening and increased resolution of the reflexions. The side-chain reflexion, which is rather diffuse in photographs of dry specimens, reveals three distinct components at 10·6 A., 9·3 A. and 8·2 A., respectively.

A technique has been tried of stretching flagellar films by drying pools of sol on silicone rubber, then re-moistening and stretching the two together. This procedure was found to produce certain changes in the X-ray diagram, and in particular there appeared a very strong and sharp equatorial reflexion at 9·3 A., even with dry specimens.

Further details of these experiments will be given in the full account of the X-ray investigations carried out at Leeds and Uppsala.

I am much indebted to P. H. Lindgren and Dr. E. Ribi for valuable help and advice in the X-ray technique.

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[1] Astbury, W. T., and Weibull, C., *Nature*, **163**, 280 (1948).

[2] Boyes-Watson, J., Davidson, E., and Perutz, M. F., *Proc. Roy. Soc.*, A, **191**, 83 (1947).

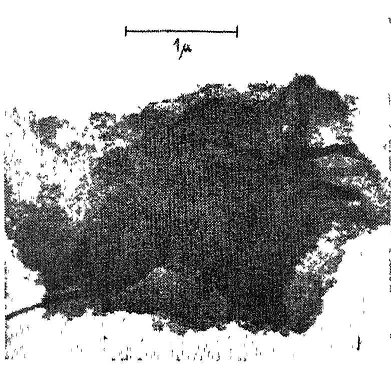
Electron-Microscopic Demonstration of a Membrane Structure Isolated from Nerve Tissue

Using a technique of preparation similar to the one used for the analysis of the ultra-structure of the outer segment of retinal rods[1], it was possible to isolate a characteristic structure from the peripheral nerve tissue of the guinea pig. The sciatic nerve or motor roots of the spinal cord were fixed (24 hr.) in 2 per cent osmic acid, moderately fragmented by crushing between the ground-glass surfaces of a small glass joint by careful grinding and afterwards fragmented by sonic treatment using a frequency of 9 kc./s.

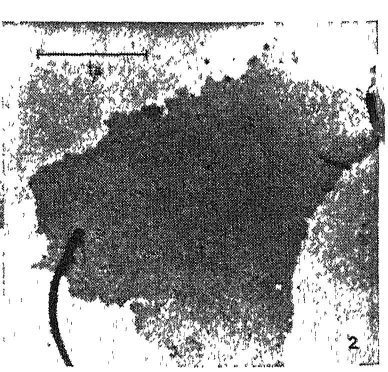
A mixture of sheets of varying thickness and fibrils, the latter obviously constituting the so-called neurotubules, was obtained. By differential centrifugation the thinner membranes could be separated from the fibrils, and almost pure preparations of the membranes resulted. The preparatory work was performed at + 4° C. An *RCA* electron microscope, type *EMU*, was used for the analysis.

The membranes are irregularly formed fragments of more extensive membranes of indefinite size, and the thicker membranes (Fig. 1) are composed of varying number of layers of thin membranes showing a uniform thickness (Fig. 2). The thickness is of the same order of magnitude as the unit disks of the retinal rod outer segments.

The membranes show a characteristic structure with dense spots arranged in larger or smaller areas scattered at random all over the membrane. On



1



2

shadowed preparations these dense spots correspond to knobs rising slightly over the surface of the membrane. The high density of these spots cannot be explained only by the greater thickness compared to the rest of the membrane, but depends probably on the accumulation of heavier atoms.

As the material used in this investigation is complex, containing many different structures, such as axis cylinders, myelin sheets, Schwann cells and connective tissue, the localization of these membranes within the nerve tissue cannot be determined by this technique. It seems probable that the membranes belong to the myelin sheets. The amount of membranes in comparison to other structures (mostly fibrils) in the fragmented but not fractionated preparation indicates that they constitute a considerable proportion of the material obtained.

Analysis by polarized light and X-rays also indicates the existence of multilayered protein membranes arranged concentrically around the axis cylinders. Assuming the observed membranes to be located in the myelin sheets, there is a striking similarity in the ultra-structure of this part of the cell and the retinal rod outer segment, as is also demonstrated by polarized light. The dense spots might well correspond to artefacts produced by the fixing agent.

Attempts to establish the localization of these membranes in the nerve tissue will be made using thin sections. These observations were made when working in the Department of Biology, Massachusetts Institute of Technology, Cambridge, Mass.

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Preparation of Carrier-Free Iron-59

THE importance of iron-59 as a biological tracer in the human body has made it imperative to investigate methods for its preparation at Harwell. It can be obtained by the (n,p) reaction on cobalt. Normally, the cyclotron is used as a source of fast neutrons to avoid simultaneous formation of cobalt-60 by (n,γ) reaction; but that course was not possible in Great Britain. Consequently, we have developed a method for treating the active cobalt obtained by irradiation in the mixture of slow and fast neutrons available in the Harwell pile (B.E.P.O.). Since the cobalt activity is some three thousand times that of the iron, it is necessary to handle radioactivity at the curie-level in order to produce a few hundred microcuries of iron-59. We considered that a solvent extraction procedure would probably be best suited for overcoming this technical difficulty.

All previously reported preparations of iron-59 from irradiated cobalt have been diluted with more or less inactive iron, derived either from deliberately added carrier or from impurity in the original cobalt[1,2]. We have found that the isotope can be extracted carrier-free into xylene as the acetylacetonate; the extraction is quantitative provided the aqueous solution of the cobalt is in the pH range 4·0–7·0. This is in contrast to the extraction of ferric chloride into ether, which is only quantitative with macro amounts of iron.

Starting with spectroscopically pure cobalt, we have obtained the same yield of iron-59 by this method and by precipitation of ferric hydroxide after addition of a milligram of iron as carrier, which shows that the extraction of iron-59 from irradiated cobalt is practically 100 per cent efficient by this method. As noted by Livingood and Seaborg, the ferric hydroxide has to be reprecipitated at least three times with cobalt hold-back carrier at each stage to give a final precipitate free from cobalt activity[2].

In performing an extraction, we dissolve the cobalt in the form of metal 'sponge' in $3N$ nitric acid and adjust the pH by addition of ammonia and ammonium acetate. A drop or two of acetylacetone, or about 1 ml. of a saturated aqueous solution of acetylacetone, is added and the solution extracted with xylene. The xylene is separated, washed with water and removed by evaporation; any charred organic residue is destroyed by fuming with perchloric acid, and the residue is taken up in a little dilute hydrochloric acid. No cobalt or iron is detectable spectroscopically in the xylene extract and only very little iron in the final product, provided that all reagents are of 'AnalaR' standard, that the xylene is carefully purified by acid and alkali washes followed by distillation and that spectroscopically pure cobalt is used.

The radioactive purity of the product has been demonstrated by decay and by absorption in aluminium. Although the former has not been followed long enough to allow us to quote a figure for the half-life, it definitely favours Govaerts's figure of 45 days[3] rather than the 47 days of Livingood and Seaborg[4]. The latter was determined from the initial decay of a mixture of iron-59 and iron-55, whereas the former is deduced from the decay of iron-59 obtained from cobalt.

The specific activity of our product is at least 1,000 μc./mgm. after irradiation for a month.

Full experimental details will be published later.

Our thanks are due to the director of the Atomic Energy Research Establishment for permission to publish this note.

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W. R. E. MATON
W. T. SPRAGG

Atomic Energy Research Establishment,
Harwell,
Didcot, Berks.
Dec. 21.

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[2] Livingood, J. J., and Seaborg, G. T., *Phys. Rev.*, 54, 51 (1938).

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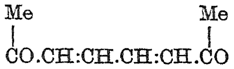
Intermediates for Polyene Syntheses

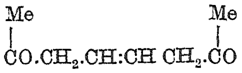
INTEREST in the diketones octa-3 : 5-diene-2 : 7-dione (I) and oct-4-ene-2 : 7-dione (II) arises mainly from their potential value as intermediates for polyene syntheses.

Recently, Karrer *et al.*[1] have announced the preparation of (I) by the condensation of glyoxal with acetoacetic acid, and have since described[2] the experimental conditions under which yields of *c.* 4 per cent may be obtained. Reduction of a pyridine solu-



$\overset{\text{Me}}{\overset{|}{\text{CO}}}\text{.CH:CH.CH:CH.}\overset{\text{Me}}{\overset{|}{\text{CO}}}$

I



$\overset{\text{Me}}{\overset{|}{\text{CO}}}\text{.CH}_2\text{.CH:CH CH}_2\text{.}\overset{\text{Me}}{\overset{|}{\text{CO}}}$

II

$\text{HOCO.CH·CH.CH:CH.COOH}$ V

$\text{HOCO.CH}_2\text{.CH:CH.CH}_2\text{.COOH}$ III

$\text{Me}_2\text{C(OH) CH}_2\text{.CH:CH.CH}_2\text{.C(OH)Me}_2$ IV

tion of (I) with zinc and acetic acid gave (II) in 70–75 per cent yield[2]. In view of these publications, we are prompted to report the methods by which we have synthesized the diketones (I) and (II).

Dihydromuconic acid (III) was readily prepared by reaction of 1 : 4-dibromobut-2-ene with cuprous cyanide in acetonitrile, and hydrolysis of the resulting 1 : 4-dicyanobut-2-ene (30–35 per cent overall yield). Treatment of the diacid chloride of (III) with cadmium dimethyl gave, in 15 per cent yield, the required diketone (II), melting point 35–36° (found : C, 68·4 ; H, 9·0 ; calc. for $C_8H_{12}O_2$: C, 68·55 ; H, 8·65 per cent) (Karrer *et al.*[2] give m.p. 30–31°), which was characterized as the *bis*-2 : 4-dinitrophenylhydrazone, melting point 208–209° (found : C, 48·1 ; H, 4·15 ; N, 22·55. $C_{20}H_{20}O_8N_8$ requires C, 48·0 ; H, 4·05 ; N, 22·4 per cent). The optimum conditions for the preparation of (II) by this route have not as yet been elucidated. In this work the cadmium dimethyl solutions used were prepared from methylmagnesium bromide and cadmium chloride, and were shown by application of the Gilman test to contain none of the Grignard reagent (cf. Cason[3]). However, in some experiments, the diketone (II) was obtained in admixture with a glycol (probably IV), melting point 86° (found: C, 69·4 ; H, 11·4. $C_{10}H_{20}O_2$ requires C, 69·7 ; H, 11·7 per cent), which on catalytic hydrogenation yielded 2 : 7-dimethyloctane-2 : 7-diol. The latter crystallized from a mixture of ether and light petroleum (b.p. 40–60°) in needles, melting point 92–93°, and from water in plates, melting point 58–59° (Zal'kind and Aizikovich[4] give melting point 88–89° from light petroleum and 57–59° from water).

When the diacid chloride[5] of *trans trans* muconic acid (V) was treated with cadmium dimethyl, a product was obtained from which the diketone (I) was readily isolated, albeit in very poor yield (*c.* 2 per cent). The diketone, melting point 126–127°, exhibited light-absorption maxima (in alcohol) at 2720 and 2790 A., ε = 31,000 and 32,000 respectively (Karrer *et al.*[1] give melting point 126–126·5° ; light absorption maximum in alcohol, 2760 A. ; ε = 33,000).

We wish to thank Sir Ian Heilbron for his interest in this work, and one of us (F. S.) thanks the Department of Scientific and Industrial Research for a senior award.

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B. C. L. Weedon
Imperial College of Science and Technology,
London, S.W.7.
Nov. 1.

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[1] Karrer, P., Eugster, C. H., and Perl, S., *Helv. Chim. Acta*, **32**, 1013 (1949).

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Heat of Formation of the Grignard Reagent, CH_3MgI : Ether

Experimental determinations of carbon-metal and carbon-halogen bond dissociation energies have been investigated in this Department during the past few years[1-4]. The first work undertaken was a calorimetric study of the formation and subsequent decomposition of a Grignard reagent.

$$R\text{I, ether} + \text{Mg} \rightarrow R\text{MgI : ether} + Q_1 \qquad (1)$$

$$R\text{MgI : ether} + \text{H}_2\text{O} \rightarrow R\text{H} + \text{MgIOH, ether} + Q_2 \qquad (2)$$

From (1) and (2), the heat of formation of the *R*I compound can be obtained:

$$Q_f(R\text{I},l) = Q_f(R\text{H},g) + Q_f(\text{MgIOH, ether}) - Q_f(\text{H}_2\text{O},l) - Q_1 - Q_2. \qquad (3)$$

From $Q_f(R\text{I},g)$, and the corresponding *R*—H dissociation energy, the *R*—I bond dissociation energy can be found. Even if the absolute value of the heat of formation as given by (3) is doubtful (owing to uncertainty in the value assumed for Q_f(MgIOH)), the gradations in Q_f values for a series of *R*I compounds should be reliable.

It soon became clear that the study of this reaction with the required degree of accuracy would be both a difficult and long task ; so it was allowed to take second place to work on the hydrolysis and iodination of the alkyls of zinc, cadmium[1,2] and mercury. But the earlier studies were sufficiently complete to enable us to give a value for Q_f (CH_3MgI : ether) which is an important thermochemical datum in view of the great versatility of the Grignard reagent.

The reaction

$$\text{CH}_3\text{I, ether} + \text{Mg} \rightarrow \text{CH}_3\text{MgI : ether} + Q_1$$

was studied *in vacuo* in an adiabatic calorimetric system[1]. The percentage reaction and the extent of any side reactions were checked by decomposing the Grignard reagent with water and analysing and measuring the gas produced. Experiments carried out in this way with reagents of high purity went cleanly with negligible side-reactions.

It was found that $Q_1 = 65·4^5 \pm 0·2$ k.cal./mole, leading to,

$$Q_f(\text{CH}_3\text{MgI : ether}) = 65·4 + Q_f(\text{CH}_3\text{I, ether}).$$

Using the value of $3·6^5 \pm 0·1$ k.cal./mole for $Q_f(\text{CH}_3\text{I},l)$[2] (methyl iodide has a negligible heat of solution in ether), we obtain

$$Q_f(\text{CH}_3\text{MgI : ether}) = 69·0 \pm 0·3 \text{ k.cal./mole.}$$

This value applies to a Grignard solution of 1 mole CH_3MgI in *c.* 22·5 moles diethyl ether.

It is hoped shortly to widen the scope of this work on the lines indicated above.

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Nov. 23.

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* Now at the University of Leeds.

[1] Carson, Hartley and Skinner, *Proc. Roy. Soc.*, A, **195**, 500 (1949).

[2] Carson, Hartley and Skinner, *Trans. Farad. Soc.*, [**45**, 1159 (1949)].

[3] Carson and Skinner, *J. Chem. Soc.*, **201**, 936 (1949).

[4] Carson, Pritchard and Skinner, *J. Chem. Soc.*, [656 (1950)].

Composition of the Grignard Reagent

In 1912 Jolibois[1] suggested that the formula of the Grignard reagent was R_2Mg.MgX_2, and since that time there have been several controversial papers dealing with experimental evidence for and against this idea. The work of W. Schlenk and W. Schlenk, jun.[2,3], in which the halogen was entirely precipitated from ether solutions of the Grignard reagent with dioxane, leaving dialkylmagnesium, led them to favour a slow equilibrium in the reaction

$$2R\mathrm{Mg}X \rightleftharpoons R_2\mathrm{Mg} + \mathrm{Mg}X_2 \qquad (A)$$

as the best explanation of the results obtained. This idea of the composition of the Grignard reagent has been popularly held ever since, in spite of many reasons for doubting how anything so simple can fit all the complex results obtained—for example, those of Noller and White[4], in which dialkylmagnesium returned to the solution on further shaking the precipitate with the solution after precipitation.

The results of Noller and White are perfectly understandable on the basis of the slow equilibrium of $R$Mg$X$ and a complex of R_2Mg with MgX_2 never being obtained,

$$2R\mathrm{Mg}X \rightleftharpoons [R_2\mathrm{Mg.Mg}X_2], \qquad (B)$$

and the postulate that there is practically no free dialkylmagnesium in the ordinary Grignard solution. (Incidentally, the ease with which dialkylmagnesium solutions catch fire as compared with those of the Grignard reagent is difficult to account for on any other basis.) Any solution containing R_2Mg.MgX_2 will be in equilibrium with a small but finite amount of R_2Mg according to the equation

$$R_2\mathrm{Mg.Mg}X_2 \rightleftharpoons R_2\mathrm{Mg} + \mathrm{Mg}X_2, \qquad (C)$$

requiring that

$$\frac{(R_2\mathrm{Mg})(\mathrm{Mg}X_2)}{(R_2\mathrm{Mg.Mg}X_2)} = K_1. \qquad (1)$$

As soon as a solution becomes saturated with respect to R_2Mg.MgX_2, the concentration of this complex is constant and

$$(R_2\mathrm{Mg})(\mathrm{Mg}X_2) = K_2. \qquad (2)$$

When dioxane is added to the solution, both compounds in equation (B) are precipitated, and only after sufficient dioxane has been added to make the solution saturated with respect to MgX_2 (present in only small concentrations) can the R_2Mg, originally present as R_2Mg.MgX_2, return to the solution, as will then be required to satisfy equation (1). In fact, equation (2) requires a fixed concentration of R_2Mg for a given ratio of dioxane to ether when MgX_2 starts to be precipitated. The $R$Mg$X$, of course, stays in the precipitate.

We have been able to demonstrate that a solution of methylmagnesium iodide in di-n-butyl ether contains no free dimethylmagnesium by some extremely simple and conclusive experiments.

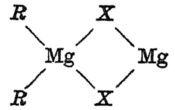
Brugger[5] found that such solutions reacted with acetone in di-n-butyl ether very rapidly (half-life about 7 × 10^{-3} sec. at 27°) according to a reaction independent of the acetone concentration and dependent on the first power of the total Grignard concentration. Exactly the same rate ($k_1 \approx 100$ sec.$^{-1}$ at 27°) was obtained with ethyl acetate.

Recently, we have carried out similar experiments with solutions of dimethylmagnesium prepared by precipitation from diethyl ether with dioxane, and transferred to di-n-butyl ether by distilling the dioxane and ethyl ether away, using a good fractionating column, under an atmosphere of nitrogen after adding di-n-butyl ether. The rate was found at 27° to be about fifty times that observed by Brugger. In this experiment, the final constant temperature down the tube of the rapid-rate apparatus[6] corresponded approximately with the total heat (48·4 k.cal.) determined in our laboratory[7,8] on the basis that only one methyl group reacted per mole of dimethylmagnesium; whereas, in Brugger's experiments, it varied from 25 to 40 per cent of the rise expected from the heat determined in this laboratory calculated on the basis of all being CH_3MgI, but 50–80 per cent on the basis of all being $(CH_3)_2Mg$, with only one methyl group reacting.

Quite clearly there can be no appreciable amount of free dimethylmagnesium in the di-n-butyl ether solution of the Grignard reagent, and the slower rate of reaction in this case is either due to the rate of dissociation of $(CH_3)_2Mg.MgI_2$, or, less likely, the slow rate of dissociation of $CH_3MgI\ [(C_4H_9)_{2x}O]$.

This last conclusion is made necessary because the total heat liberated when methyl magnesium iodide reacted with acetone in the rapid-rate apparatus, at the point down the tube where the temperature became constant, is only a fraction of the measured heat of the reaction. This fact indicates that one of these species must react very slowly. Assuming that the rate of the $(CH_3)_2Mg.MgI_2$ dissociation determines the rate, Brugger's results point to more than 50 per cent of the Grignard solution existing as $(CH_3)_2Mg.MgI_2$, or the other assumption to more than 60 per cent. Further experiments are in progress.

The conclusion that the Grignard reagent has the formula



has been made previously by Evans and Lee[9] from experiments on electrolysis and transference.

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[6] This apparatus was essentially like that of La Mer and Reed (*J. Amer. Chem. Soc.*, **52**, 3098; 1930), with the fraction which had reacted down the tube measured by the temperature-rise indicated by suitably placed thermocouples.
[7] Aston, J. G., and Bernhard, S. A. (to be published).
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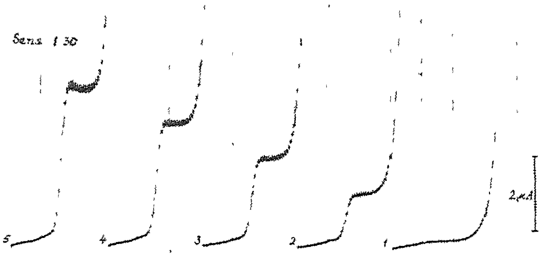
[9] Evans, W. V., and Lee, F. H., *J. Amer. Chem. Soc.*, **56**, 654 (1934).

Polarographic Behaviour of Acetone

In supporting electrolytes generally used in polarography, for example, in solutions of potassium, lithium or ammonium salts or lithium hydroxide or in buffer solutions, no polarographic reduction wave of acetone can be observed. Only if electrolytes of tetra-alkylammonium are used can a reduction wave at a half-wave potential of about − 2·1 V. (from



Dependence of the height of wave on concentration of acetone in 1·5 N ammonia, 1·5 N ammonium chloride; concentration of acetone: (1) 0; (2) 0·018 M; (3) 0·035 M; (4) 0·051 M. Abscissæ, 0·2 V.; curves start from − 1·2 V. (S.C.E.); rate of flow, m = 2·13 mgm./sec.; dropping time, t = 3·2 sec.

saturated calomel electrode) be obtained[1,2]. After conversion of acetone to its hydrazone or phenylhydrazone, two reduction steps are obtained[3], but none is suitable for analytical purposes; moreover, the height of these waves is not a linear function of concentration. Thus acetone is polarographically determined in an indirect way in acid sulphite solution, with which it reacts as other ketones and lowers the acid sulphite wave[4].

When studying the reactions of amines with carbonyl compounds, for example, in concentrated solutions of ammonia – ammonium sulphate buffer of pH 9·3, I have found a well-developed wave due to acetone with a half-wave potential of about − 1·6 V. The height of the wave is a linear function of the concentration of acetone (see diagram), and such solutions are therefore well suited for analytical purposes. Since acetone is volatile, the polarographic curves must be recorded after passing an indifferent gas through the solution for a constant time. At greater concentrations of acetone it is possible to record curves even in the presence of air. Another NH_2-compound which is less volatile than ammonia is being sought.

It has been ascertained that the acetone substance reduced at − 1·6 V. is a compound formed by one molecule of acetone and one molecule of ammonia. It is supposed that the polarographic wave is due to the reduction of the imino group. The compound formed is in equilibrium with free acetone, and the height of the wave is influenced by the concentration of free ammonia. Since its dissociation into ammonia and acetone is large and because the concentration of the buffer solution used was limited by the solubilities of ammonium salts, it was impossible to reach the full diffusion current corresponding to acetone according to the Ilkovič equation. In 10 N ammonia saturated with ammonium chloride, the height of the wave was about 20 per cent of the wave due to the same molar concentration of pyruvic acid. This means that acetone may be polarographically estimated in concentrations of 0·1–0·00002 M. The equilibrium state is reached in 15 sec. after the beginning of the reaction. The electrode process is limited only by diffusion, and therefore the limiting current corresponds to the true equilibrium concentration in the bulk of the solution.

Many carbonyl compounds were found to react in a similar manner, the reaction product being reduced at different potentials. The reaction with the carbonyl group was found to take place only with primary amines (or amino-acids), that is, with the amino-group, and has been followed in the case of pyruvic acid, acetaldehyde, benzaldehyde, benzil, diacetyl, phenylglyoxylic acid, coumarindion and dehydroascorbic (or diketogulonic) acid. The study of these reactions and of their equilibrium and rate constants is being continued.

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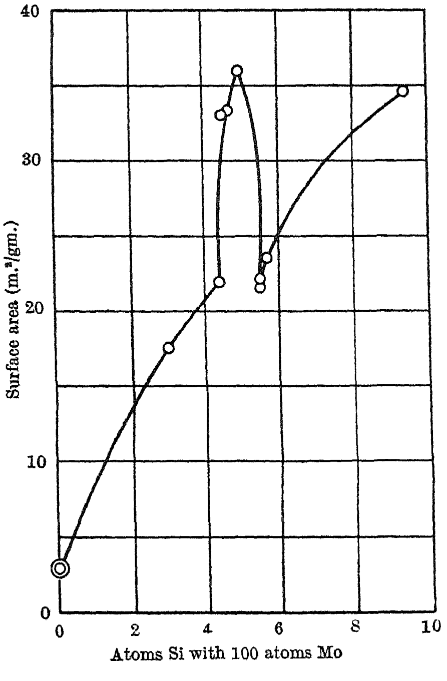
Physical Properties of Promoted Molybdenum Catalysts

The addition of small quantities of promoters to molybdenum oxide catalysts is known to produce striking changes in their activity for hydrocarbon decomposition[1]. These effects have been related to differences in their capacity for the chemisorption of hydrocarbons at or near the reaction temperature[2]; but no fundamental reason for these observations was found.

We have now studied other physical properties of these catalysts, prepared by reducing, in hydrogen at 450°, molybdic acid to which known amounts of silica sol were added. Surface areas were measured by the method of Brunauer, Emmett and Teller[3] with results shown in the accompanying diagram.

These results indicate that the addition of the promoter first causes an increase in the surface area, directly related to the concentration added, but that beyond the point of highest catalytic activity when 4·4 atoms of silicon accompany every 100 atoms of molybdenum, a drastic change takes place in the structure. Measurements of the electrical properties of these catalysts also show that distinctive changes



again occur at the same critical concentration. This work is being continued, and the results will be published elsewhere in full.

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Thermal Diffusion of Water-Vapour

WE have found that in a hot-wire Clusius column operating with water-vapour, molecules containing oxygen-18 concentrate at the *top* of the column. This is an unexpected result, since it implies that the water molecule under these conditions must be softer than a Maxwellian molecule. From our results an approximate calculation on the basis of the Furry and Jones theory[1] indicates a force-factor of 4·9.

The column used, 200 cm. long and 1·45 cm. internal diameter, was of glass. A platinum wire of 0·015 in. diameter was fixed axially and heated to 900° C.; this kept the walls of the column a little above 100° C. when a wire screen was put round to stop draughts. At one end of the column a side-tube communicated with a small reservoir containing 2 c.c. of liquid water maintained at 100° C. by a jacket containing boiling water open to the atmosphere. At the other end a side-tube communicated with a small bulb which could be sealed off for sampling. A mercury manometer was used for measuring the pressure inside the column, which was approximately atmospheric.

Experiment	Time of operation (hr.)	Ratio of O^{18}/O^{16} in sample
1. Sample from bottom of column	30	0·18 per cent
2. Sample from bottom of column	8	0·18 ,,
3. Sample from top of column	4	0·22 ,,
4. Sample of ordinary water	—	0·20 ,,

The percentage of oxygen-18 in a sample was found by converting the water to carbon monoxide and dioxide and then using a mass-spectrometer. The results are shown in the accompanying table. No experimental determination was made of the equilibrium time of the column; but it was apparently less than four hours.

We should like to thank Mr. J. Blears and Mr. D. L. Nicholson, who carried out the mass-spectrometer assays in this laboratory.

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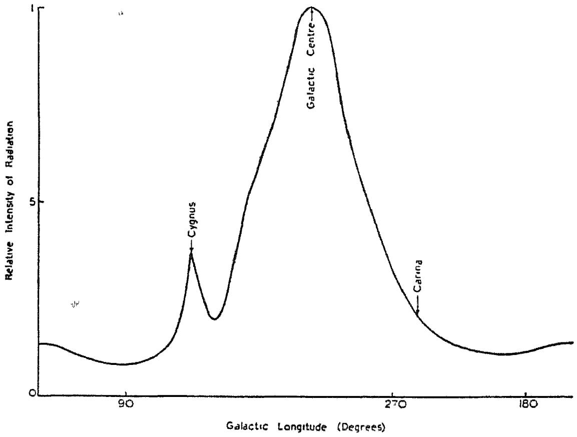
[1] *Rev. Mod. Phys.*, **18**, 151 (1946).

Structure of the Galaxy and the Sense of Rotation of Spiral Nebulæ

WE have recently completed a survey of galactic noise over the southern skies at a frequency of 100 Mc./s.[1]. This, in conjunction with previous surveys by Hey, Parsons and Phillips[2] (64 Mc./s.) and Reber[3] (160 Mc./s.), has been used to provide information on the distribution of material in our galaxy.

Hubble has shown that the size of the external galaxies increases steadily with increasing spiral structure; our own galaxy, which is comparable in size with the largest of the external systems, may, therefore, be expected to show some spiral formation. If the intensity of radio-frequency radiation from a given direction be taken as an indication of the extent of galactic material in that direction, radio observations may be used to provide evidence as to the structure of the galaxy. From the surveys of galactic noise referred to above, the distribution of intensity over the whole celestial sphere has been obtained. Corrections were made in Cygnus[4] and Cassiopeia[5] for the effects of the intense discrete sources in these constellations. The important features of the resulting distribution are an extended principal maximum in the direction of the galactic centre, and a sharp secondary maximum in Cygnus. These maxima appear on the section through the galactic plane shown in the accompanying graph. These observations can be interpreted as placing the sun in or near the arm of a spiral galaxy, this arm extending from Carina through the region of the sun to Cygnus.



Distribution of equivalent temperature along the galactic equator

An optical determination of the location of the sun with respect to possible spiral features requires a knowledge of the star distribution in the region around the sun. Present data, however, are limited to certain regions up to a distance of 5,000 light-years, and may be affected by incomplete information on the absorption in interstellar space. It appears, however, that in most directions the star density remains constant for the first 1,000 to 2,000 light-years, thereafter decreasing. The exceptions are, first, an initial decrease followed by large increases at 3,000–5,000 light-years in the general direction of the galactic centre; and secondly, constant density for at least the first 5,000 light-years in the direction of Cygnus and Carina. It would seem that there is a general concentration of stars towards a line running from Carina through the sun towards Cygnus, with a vacant lane between this line and a 'nucleus'. Perhaps more marked is the concentration towards this line of those stars (Types *O* and *B*) which, in extra-galactic nebulæ, show preference for the spiral arms. Further, the dark nebulæ forming the Rift may be compared with the dark markings often noticeable between the arms and the nucleus in external systems. The optical evidence, therefore, though not conclusive, is reasonably consistent with the hypothesis of the spiral formation for our galaxy suggested by the radio-frequency measurements.

The direction of rotation of the galaxy is known from astronomical observations of the apparent motion of stars and star clusters, and if the radio observations can be interpreted in terms of a spiral structure with an arm opening out in the direction of Cygnus, the sense of rotation is that of a spiral unwinding. This sense of rotation has not been previously established. It is consistent with the dynamical theories of Lindblad[6] and Milne[7] on the formation of spiral systems; but disagrees with the sense of rotation in extra-galactic nebulæ inferred by Hubble[8] from interpretation of the dark markings.

The results outlined here will be discussed in more detail elsewhere.

We wish to acknowledge the assistance of Messrs. G. J. Stanley and O. B. Slee in making observations concerned in this work which is part of the research programme of the Division of Radiophysics, Commonwealth Scientific and Industrial Research Organisation, Australia.

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Pleistocene Deep Weathering

SIR EDWARD BAILEY has sent me a copy of his letter[1].

The decay of these rocks is neither pre-Glacial nor, in the ordinary sense, due to weathering; it is a post-Glacial rotting, usually from a ground-water rich in peat acids. We know that, because boulders (mostly, of course, granite, schist or limy rocks) remain fresh throughout a stiff, impervious till, but are rotted wherever that till has a loose, earthy texture and/or is in a 'flow-earth' state, through that solifluxion which twice obtained in early post-Glacial times.

The shattered rock at Tynemouth (whoever claimed it as a boulder-clay ?) is, as a 'head'[2], as much a myth as is the cliff from which it presumably came. I have distrusted Sir Edward's judgment on these matters ever since his acclaim of a pre-Glacial weathered surface at Hessle, another myth long since exploded. The few pre-Glacial 'heads' known are all in sheltered positions: that at Bridlington is snugly tucked away in a cliff foot behind Flamborough Head. Contrast this with the huge crumples in the chalk, and the incessant rafting on the exposed sea-face of the headland.

For too long Sir Edward has had the idea that great ice-sheets can, over vast areas, be utterly innocuous to all beneath them. So was born the quaint belief in the immunity of frozen ground, thought to account for 're-advance' tills on undisturbed sand—a belief quite against the physical evidence, and one which ignores those transported 'rafts' of sand and clay, the parent strata of which really were frozen, as shown by their shattered margins and intact interior; proof enough, surely, that freezing has not saved them from the common fate. Nevertheless, this belief is not easy to reconcile with his public announcement, when confronted with an 'Upper Till' contact on unmoved sand, with the most obvious of roof-falls therein, that these represented "repeated surface creeps of boulder-clay".

Personally, I would not call a glaciation weak which carried trails (whether on or under the ice is immaterial) of Highland rocks and sea-bottom across Caithness, or Shap granite and Whin Sill along the Yorkshire coast, besides Southern Upland and Border rocks the whole way down to Norfolk.

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Jan. 8.

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[1] *Nature*, **164**, 1130 (1949).

[2] For the criteria of 'head', see Wright, W. B., "The Quaternary Ic Age", 113 (2nd edit.; Macmillan, London).

THE recent communication by Sir Edward Bailey[1], describing the brecciation of rocks beneath boulder clay, is most interesting, and his opinion that this phenomenon is unlikely to be due to ice-movement agrees with my own observations. Examples can be seen in many places, and a particularly striking one was observed by me recently near Bury St. Edmunds, where chalk was seen to be shattered for a depth of 15 ft. below boulder clay. The glacial deposit at this section consisted largely of rounded pellets in a matrix of powdered chalk and sand, with many flints and occasional fragments of Jurassic septaria, Bunter quartzites and rare pebbles of Old Red Sandstone porphyrites. The state of the chalk under this boulder clay contrasted with that in the glacial deposit, as it was broken into angular pieces, but no rock fragments foreign to the chalk were found. Occasional rafts of this chalk-breccia had been thrust up into the boulder clay.

The simplest explanation of these facts seems to be that the chalk was first broken into angular 'head' by frost action at some time before the arrival of the ice-sheet, and the ice which advanced later over the frost-shattered surface derived much of its chalk-content from this 'head', rounding the angular fragments in the process. Many examples of disrupted rock below boulder clay which have been seen in northern Britain seem to have a similar explanation, namely, a period of frost-action before the arrival of the ice. This interpretation is not new, but seems to be confirmed by the examples under discussion, although dislocation of the solid rock by the mechanical thrust of the ice may have taken place in some cases, as, for example, the famous chalk erratics of Cromer.

The examples of weathered rock below boulder clay discussed by T. C. Phemister and S. Simpson[2] are also most interesting, as there is no doubt that the Pleistocene ice worked on weathered surfaces at some places. The erratics of weathered Cheviot porphyrites associated in some boulder clays with fragments of other rocks which are quite fresh, for example, limestones, support this view. It may be very important to note that this explanation affects our ideas on the weathering of boulder clays in general, and, although some glacial deposits show true weathering of their own upper layers, examples which contain previously weathered material incorporated with fragments of unweathered rock must be remembered in trying to 'date' boulder clays by their degree of weathering.

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[1] *Nature*, **164** 1130 (1949).

[2] *Nature*, **164**, 318 (1949).

Flow of Mild Steel in the Austenite Range, 950-1,400° C.

IN the case of pure metals of cubic symmetry subject to external stresses at temperatures where work-hardening is practically absent, the theory of molecular rate processes yields for the natural tensile strain-rate $\dot{\varepsilon}_v$ of the quasi-viscous flow, as observed after the termination of the period characterized by internal adjustments due to transient creep, the expression[1]:

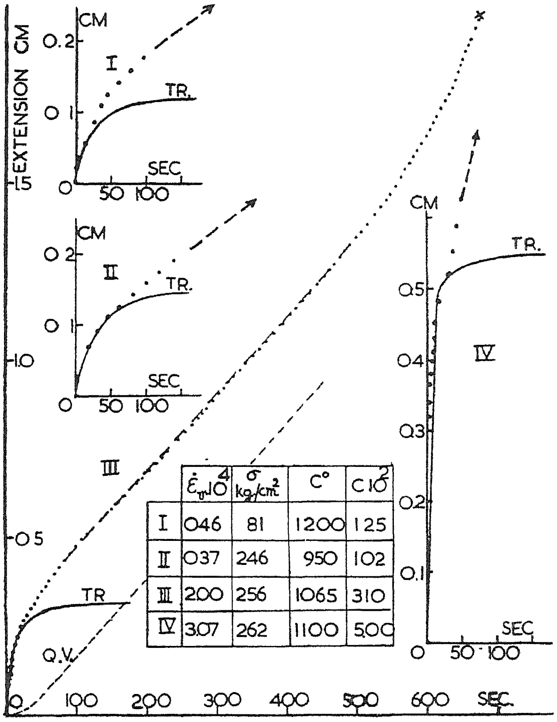
$$\dot{\varepsilon}_v = A.T.\exp(-H/kT)\,.\,\sinh(q\sigma/kT), \qquad (1)$$

where σ is the applied tensile stress, q a constant which can be considered as the product of a dimensionless stress-concentration factor and a constant having the dimensions of a volume. Although the parameter A, which also embodies the entropy of activation of the process by which dislocations are assumed to be generated, is dependent upon the dimensions of the mosaic blocks and upon the specific mode of slip which is operative, it is regarded as constant in the present work, particularly as variations in its magnitude at temperatures above the A_3-point would be largely concealed even by small errors in the exponential term of equation (1).

The flow of a 0·06 per cent carbon steel was investigated over the ranges of temperature, strain-rate and stress: 950°–1,400° C., $3{\cdot}5 \times 10^{-5}$–$7{\cdot}0 \times 10^{-3}$ sec.$^{-1}$ and 80–280 kgm./cm.^{2} (approx. $\frac{1}{2}$–2 tons/sq. in.) respectively, and good agreement with the functional relationship given by equation (1) was found. If σ is expressed in kgm./cm.^{2}, then $q/k = 24{\cdot}65$; $H/k = 28{\cdot}4 \times 10^3$ and $A = 5{\cdot}0$.

The experiments were carried out *in vacuo* with polished specimens of circular cross-section of about 1·3 mm.^{2}, and of gauge-length 10 cm. when at the temperature of the experiment. The preparation of the specimens is described elsewhere[2]. The stress on the specimen was kept constant during the flow by means of an Andrade constant-stress beam.

Pronounced third-stage creep invariably preceded fracture (see complete flow curve in diagram III), even though no necking was detectable. This seems to agree with the observation of Sully[3], who found accelerating third-stage creep in compression tests on nickel–chromium alloys. Fracture of the steel generally occurred at strains of the order of 15–20 per cent.



	$\dot{\varepsilon}_v 10^4$	σ kg/cm^2	C°	C 10^2
I	046	81	1200	125
II	037	246	950	102
III	200	256	1065	310
IV	3.07	262	1100	5.00

Because of the rapid annealing in the temperature-range considered, the persistence within the metal of high local stress-peaks of the nature considered by Mott and Nabarro[4] in their exhaustion mechanism of transient creep is here improbable. Thus, in order to account for the observed pronounced transient creep, the following assumptions were made.

(*a*) The entropy of activation, as determined by the length (or equivalent length for other than edge dislocations), and not the variation in the heats of activation, controlled the rate at which already existing dislocations were effectively lost during transient creep.

(*b*) Interaction between moving dislocations was negligible.

(*c*) The product of the number of dislocations of length L at the time of application of the stress, and the length L was constant for all lengths, that is,

$$N_L(0)\,.\,L = \text{const.}\,;\ L_0 \leqslant L \leqslant L_m. \qquad (2)$$

(*d*) The amount of slip associated with the loss of a dislocation in transient-creep was proportional to its length. On this basis the transient creep strain was found to be given by:

$$\varepsilon_{tr} = a.C.\Big[f(L_0) - f(L_m)\Big] - \frac{1}{t}\Big[\exp\,(-\,C.f(L_m).t - \exp\,(-\,C.f(L_0).t\Big], \qquad (3)$$

where a, $f(L_0)$ and $f(L_m)$ are constants which were found to have the values 0·224, 6·0 and 0·4 respectively; while C is a stress and temperature-dependent function given by

$$C = A'.T.\exp(-H'/kT).\sinh(q'\sigma/kT), \quad (4)$$

with $A' = 3{\cdot}2 \times 10^{-2}$; $H'/k = 12{\cdot}6 \times 10^{3}$; $q'/k = 15{\cdot}10$; and t is the time in seconds, measured from the instant of the application of the tensile stress σ.

The full curves in the diagrams were drawn from values obtained from equation (3); the dots represent experimental points, and the broken curve drawn in diagram III represents the quasi-viscous flow. It was obtained by subtracting the transient from the overall flow curve. During the period of pronounced transient creep, the stress-concentration factor q (equation 1) cannot be expected to have attained its final value. It will reach that value only as the metal 'hardens' in the course of the decay of the transient flow. The quasi-viscous creep curve will, therefore, be bent near the origin, as is shown in diagram III.

The effect of carbon content, alloying, and specimen size on the flow is being studied.

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[2] Feltham, P., *Metallurgia*, 60 (Nov. 1949).

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Biological Control of the Mealybug Vectors of Swollen Shoot Virus of Cacao

IN view of the results obtained by Boyce and Fawcett[1], working with *Aspergillus parasiticus* Speare as a parasite of *Pseudococcus gahani* Green and *Phenacoccus gossypii* T. and C., it was considered worth while to initiate preliminary investigations designed to show whether this fungus would parasitize *Pseudococcus njalensis* Laing, the chief field vector of swollen shoot virus in the Gold Coast.

Two strains of *A. parasiticus* (*NRRL* 465 and 502, herein designated (1) and (2) respectively) were received through the courtesy of Dr. K. B. Raper, of the Northern Regional Research Laboratory of the U.S. Department of Agriculture, Peoria, Ill. Preliminary tests were made by rolling adult *P. njalensis* in sporulating cultures of the fungi. Untreated mealybugs acted as controls. From the results, it was evident that *A. parasiticus* was able effectively to attack and kill *P. njalensis* (88 per cent dead after 120 hr., compared with 11 per cent dead in controls).

A more carefully controlled experiment was then carried out under conditions more nearly those of field practicability. The spores were applied (at the suggestion of Dr. Edward A. Steinhaus, of the University of California Agricultural Experiment Station) diluted with talc dust in a dust tower. Two control treatments involving no fungus spores were employed, one in which talc dust alone was applied to the mealybugs, the other consisting of no dust application at all. As a further control, two species of *Aspergillus* other than *A. parasiticus* were applied in two treatments. These were *A. flavus* Link ex Fr. emend. Wilh., closely related to *A. parasiticus*, and *A. niger* van Tiegh. *sens. strict.* The remaining two of the six treatments were those using strains (1) and (2) of *A. parasiticus*.

Each treatment involved the application of 0·25 gm. of talc dust, containing (in treatments 1–4) approximately 12,000 fungus spores, to a hundred adult mealybugs divided into four batches of twenty-five, each batch being contained in a Petri dish of diameter 7·5 cm., to which had been added a filter paper moistened with sterile water. The four Petri dishes stood on the floor of the dust tower, of diameter 25 cm. The dust was blown upwards into the tower at a pressure of 20 lb. per sq. in. and allowed three minutes to settle.

The plates were examined daily under a binocular microscope. It was evident that under the conditions of the experiment, *A. parasiticus* could effectively parasitize *P. njalensis* within 96 hours. *A. flavus* and *A. niger* appeared to have a slightly deleterious action; most of the mealybugs which died under those treatments had fructifications of the respective fungus growing out of the corpses, usually dorsally or laterally in the thoracic region, as was also the case with the mealybugs killed by *A. parasiticus*.

The experiment was repeated ten weeks later, using the same dusts, which had been stored in corked tubes. The results were closely comparable with those of the first series. The corrected percentage deaths[2] after 96 hr. for the six treatments in the two experiments respectively are tabulated below:

	Fresh dust	Dust stored 10 weeks
1. *A. parasiticus* (1)	96	97
2. *A. parasiticus* (2)	90	97
3. *A. flavus*	7	20
4. *A. niger*	2	6
5. Control: talc alone	−1	0
6. Control: no treatment	0	0

Further work on this subject will be directed towards a study of the effect of *A. parasiticus* on mealybugs living in established colonies on cacao plants.

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Jan. 20.

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Growth of Egyptian Lambs: Effect of Artificial Feeding and Breed Differences

ARTIFICIAL feeding of lambs is not practised in Egypt, owing to the breeders' belief that lambs do not survive unless they suckle their mothers for at least three to four months. The present study was undertaken to investigate the real effect of such practice with both Awsemy and Rahmany breeds.

Twenty lambs were taken at random and divided into two equal groups, one of which was naturally fed, while the other was bottle-fed on whole buffaloes' milk. Each of these groups consisted of six Awsemy and four Rahmany lambs with the same proportion of male and female. All individuals were weighed after birth and then at weekly intervals throughout the experiment (eighteen weeks suckling and ten weeks after). The fortnightly weights, however, are taken for discussion.

(*a*) *Artificial feeding.* The experiment started with approximately the same average birth-weight for

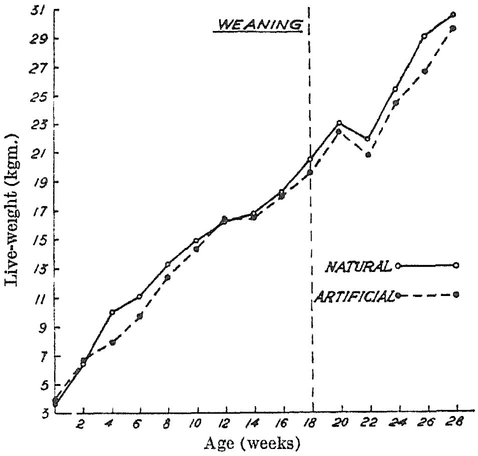

Fig. 1. Growth of lambs on natural and artificial feeding

both the naturally and artificially fed groups, namely, 3·65 and 3·88 kgm. respectively. Both groups have since grown at the same rate, as shown in Fig. 1.

The average live-weight gains during the suckling period were, thus, 16·68 kgm. for the naturally fed group and 15·63 kgm. for the artificially fed group, while the respective gains in ten weeks after weaning were 10·11 and 9·93 kgm. The differences between the gains in both periods were statistically insignificant as calculated by the *t*-test[1]. These results, together with the fact that no death occurred among the artificially fed group, are contrary to the belief of Egyptian sheep breeders previously mentioned.

The amount of buffaloes' milk given to each of the artificially fed lambs was, on the average, 80·68 litres, which is equivalent to 66·57 litres of sheeps' milk on the basis of the calorific value. This amount is about 19·21 and 44·97 litres more than the average yields of Rahmany and Awsemy ewes respectively[2]. Quantities must, therefore, be regulated on the basis of the average yield of ewes, as the extra feeding did not show any effect.

(*b*) *Breed differences*. Since there was no significant difference between the growth of lambs in both natural and artificial feeding, the fortnightly live-weights of the lambs of each breed in both groups were pooled and the averages calculated. Though the average live-weight of the Awsemy lambs was higher than that of the Rahmany, namely, 3·73 and 3·18 kgm. respectively, Fig. 2 shows that the former breed grows at a much slower rate than the latter; the respective live-weight gains being 14·12 and 19·21 kgm. during the suckling period, with a statistically significant difference of 5·09 kgm. On the other hand, this difference was insignificant during the ten-week period that followed weaning.

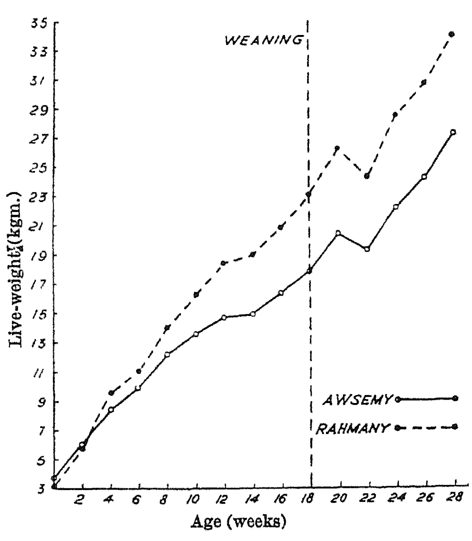

Fig. 2. Growth of Awsemy and Rahmany lambs

The average live-weight gain of the six Awsemy lambs in the artificially fed group during suckling was 12·78 kgm., while that of the four Rahmany lambs in the same group was 19·90 kgm., thus giving a significant difference of 7·12 kgm. This confirms that the Rahmany breed has a better inherited response to growth and is thus more suited for butcher's meat than the Awsemy.

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[1] Fisher, R. A., "Statistical Methods for Research Workers" (1936).

[2] Sirry, I., El-Sokkary, A. M., and Hassan, H. A. (to be published).

Production of Mutations in *Drosophila* using Four Aryl-2-halogenoalkylamines

After study of the cytotoxic effects of a long series of aryl-2-halogenoalkylamines[1], Haddow, Kon and Ross, with P. C. Koller and S. Revell, have related these effects to chromosome injury and have, in addition, proved a number of these compounds to be carcinogenic. In view of these findings, it became of interest to test whether some of these compounds could induce germinal mutations in *Drosophila*, similar to those obtained by Auerbach[2] with mustard gas and related compounds. Several of these aromatic nitrogen mustards have given encouraging results in preliminary tests using the Walker rat carcinoma as test object, and four of them have now been tested for mutagenic action on *Drosophila melanogaster*:

NN-Di-(2-chloroethyl)-*p*-toluidine (I)
NN-Di-(2-chloroethyl)-*p*-anisidine (II)
β-Naphthyldi-(2-chloroethyl)-amine (III)
β-Naphthyldi-(2-chloropropyl)-amine (IV) (mixture of isomers)

The preparation of these compounds has been reported by Ross[3] (I–III) and Everett and Ross[4] (IV).

All four were administered by feeding. The quantity was dissolved in 1 c.c. of arachis oil, and this was intimately mixed with 50 c.c. of hot agar–yeast medium. Arachis oil alone was used for the controls, and a counted number of newly hatched wild type (Oregon-*K*) larvæ added. The compounds were highly toxic, and just sub-lethal doses sterilize the adults, produce larval 'tumours' and other abnormalities. For example, I at 0·007 per cent produced 81 per cent abnormal abdomens, the sclerites being irregular both in structure and pigmentation. To test for sex-linked recessive lethals, males reared on the test media were each mated to several Muller-5 females, and 3–6 days later to another set of Muller-5 females to give a second brood. The results are shown in Table 1, from which it will be seen that all compounds produced a significant increase in the

Table 1

	Brood I		Brood II		Total		I	II	Total
	Chromosomes tested	Lethals	Chromosomes tested	Lethals	Chromosomes tested	Lethals	% Lethals	% Lethals	% Lethals
I 0·003%	745	13	235	2	980	15	1·7	0·9	1·5
I 0·007%	681	23	286	4	967	27	3·4	1·4	2·8
II 0·07%	317	9	1327	11	1644	20	2·8	0·8	1·2
II 0·09%	192	5	273	2	465	7	2·6	0·7	1·5
III 0·07%	591	5	277	2	868	7	0·8	0·7	0·8
IV 0·007%	873	6	—	—	873	6	0·7	—	0·7
IV 0·05%	101	0	155	3	256	3	0	1·9	1·2
IV 0·07%	13	0	118	5	131	5	0	4·2	3·8
Controls	2427	9	2466	3	4893	12	0·4	0·1	0·2

number of sex-linked lethals over the controls, and that these were usually more frequent in sperm produced in the earlier days of adult life. The apparent reversal of mutation-rates with IV is due to the small size of the first brood, the males being very sterile during the first few days of adult life.

Some males produced more than one lethal. Many of these have been placed genetically and only very few clusters were indicated ; most of the lethals were not identical. Some semi-lethals were also found in the F_2, and many of these proved to be gonadic mosaics of the F_1 female for a full lethal. Auerbach[5] found the same phenomenon with sulphur mustard and suggested that it indicates an induced instability of the chromosome.

I and III were tested on a small scale for the production of fragments and visibles. Males were mated to females with a marked attached-*X* chromosome. F_1 females were observed to detect deleted fragments covering one or more of the marker genes, and the F_1 males were scored for visibles. Table 2 gives the results : only one female showed the presence of a deleted fragment. The majority of visibles were Minutes, including several mosaic Minutes, while the other visibles were sex-linked recessives or autosomal dominants (non-Minute). Many of the Minutes proved sterile ; but those from which a reasonably sized F_2 could be obtained bred as autosomal dominants, and were probably mainly small deficiencies.

Table 2

	Normal diploid F_1 ♀♀	♀♀ Hyper-ploid for a deleted-X	Wild type F_1 ♂♂	Min.	% Min.	% Sex-linked recessive lethals
I 0·003%	1298..	1	1456	19	1·3	1·5
I 0·007%	1276	0	1299	12	0·9	2·8
III 0·07%	916	0	1004	9	0·9	0·8
Controls	647	0	711	1	0·1	0·2

Auerbach noted with mustard gas that the proportion of translocations, and to a smaller extent deletions, to sex-linked lethals is significantly smaller than after X-ray treatment. If this also holds for the aromatic nitrogen mustards one would scarcely expect many large deletions in the 3,490 examined, when the percentage of sex-linked lethals produced by the same dose is so low. From these results it is clear that the four compounds can produce mutations, including sex-linked recessive lethals, visibles and probably small deficiencies. The low mutation-rates compared to mustard gas may be the result of several factors, such as the indirectness of the feeding method, the toxicity of the compounds, or differences in the sensitivity of mature sperm and immature germ cells. The general toxicity severely limits the dose in feeding experiments, but other methods such as aerosol and injection are now being tried to overcome this difficulty.

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Feb. 17.

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Parthenogenetic Development of Eggs from a Cestode Cultured Aseptically *in vitro*

IT has been shown that plerocercoid larvæ of the cestodes *Schistocephalus solidus* and *Ligula intestinalis* may be cultured to maturity *in vitro* in liquid media at 40° C. under sterile conditions. In the early experiments[1,2], although sexually mature tapeworms developed, eggs produced *in vitro* failed on testing to form embryos. Histological examination revealed that spermatozoa were not present in the receptaculum seminis of the proglottids, suggesting that failure of eggs to form embryos was attributable to non-fertilization. In later experiments with *Ligula*[3], a small number (6 per cent) of embryonated eggs were obtained from larvæ cultured in horse serum.

Further experiments have now been carried out on *Schistocephalus*, larvæ being dissected aseptically from infected fish (*Gasterosteus aculeatus*) and cultured in a range of liquid media under sterile conditions at 40° C. It has been found that when the *p*H was carefully controlled (by using large volumes of serum or saline media and solid calcium carbonate) and anaerobic or semi-anaerobic conditions were maintained, worms produced eggs capable of up to 85 per cent embryonation. Such embryonation, however, was very irregular. Only about 5 per cent of developing eggs formed normal full-sized coracidia which hatched normally ; the remainder developing into aberrant types which for convenience have been termed 'miniature' and 'abnormal'.

'Miniature' coracidia were, on the average, one-third to one-half the normal size, and although perfectly developed with ciliated embryophore and hooks, failed to hatch in spite of active rotation within the eggs. Such coracidia could be hatched by pricking the egg with a glass needle. 'Abnormal' coracidia were characterized by the peculiar position of the embryophore, which, although showing ciliary movement, failed to enclose the hooked region of the idium but appeared as a ciliated ring at one end ə egg ; such coracidia could not be hatched by ing.

stological examination of cultured worms showed , even in worms giving 85 per cent egg embryona- , the receptaculum seminis was still devoid of matozoa. Since the receptaculum of worms ured naturally in a bird gut (the normal environ- it) was always filled with great masses of sperm- a, it is tentatively suggested that eggs from ms matured *in vitro* undergo parthenogenetic elopment. It is possible that the 5 per cent mal self-hatching eggs may have been fertilized, t that the small number of spermatozoa concerned uld not be distinguished in histological sections.

I am indebted to the Medical Research Council of reland for a generous grant-in-aid in connexion with his work.

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Dec. 6.

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Completion of Mitosis after Death

It has been shown that when sugar and phosphate are unavailable, mitotic activity in the mouse is severely depressed. Such a depression develops rapidly after injections of insulin or phloridzin[1] and during ischæmic shock[2]. In these circumstances the significant observation can be made that sudden sugar-lack has no effect on the completion of any mitosis already under way. It has been suggested that the great importance of sugar in cell division may be for the production of energy ; but if this is correct it is also evident that such energy is required only at the very beginning of the process[3].

The independence of the later stages of mitosis has now been strikingly demonstrated in the following manner. Sleeping mice were killed at 13.00 hr. in order that their tissues should contain a maximum number of mitoses[4], males being used in preference to females in order to avoid the effects of the œstrous cycle. Pieces of ear were removed at the time of death and at hourly intervals thereafter, and in this way it was possible to discover the fate of the many mitoses present in the epidermis. The results of an experiment, performed with ten mice, are given in the accompanying table.

Average numbers of mitoses present per unit length (1 cm.) of sections of ear epidermis (cut 7 μ thick) in a group of ten male mice killed at 13.00 hr.

Time of day	Numbers of mitoses	Phases of division
13·00	6·5 ± 0·14	*PMAT*
14·00	2·7 ± 0·19	*MAT*
15·00	1·5 ± 0·11	*AT*
16·00	0·6 ± 0·15	*T*
17·00	0·5 ± 0·14	*T*
18·00	0·6 ± 0·17	*T*

In the phases of division, *P* represents the prophase, *M* the metaphase, *A* the anaphase, and *T* the telophase.

This shows clearly that almost all the mitoses present at the time of death continued without interruption, and since it is known that in a male mouse the normal time taken for the completion of an epidermal mitosis is about 2½ hours, it is evident that the process was not even significantly delayed. The stoppage of all cell division shortly after 15.00 hr. may perhaps indicate that the epidermis itself died at about this time.

Results similar to these have been obtained from bodies kept at a room temperature of 20° C. or in an oven at 38° C., and they have also been seen in a variety of internal tissues. Evidently, so long as the cells themselves remain alive, the lack of a blood supply is no bar to the completion of cell division, and even in isolated pieces of tissue the same result has been obtained. This last observation has made possible a re-examination of the effects of oxygen-lack. Medawar[5] has already shown that oxygen is essential for the development of mitotic activity in the rabbit epidermis, and this observation has now been confirmed in the mouse. However, it has also been shown that oxygen, like sugar, is necessary only for the initiation of a mitosis, and that when a division has progressed far enough to be recognizable as a prophase, it can be completed in an atmosphere of pure nitrogen[6]

Thus the experiments so far performed with mammalian epidermis indicate that both sugar (or glycogen) and oxygen are essential for the initiation of a mitosis, but that neither is necessary for its completion. This suggests that the beginning of cell division involves the development of a significant amount of energy obtained by the aerobic destruction of sugar (or glycogen), and the evident importance of phosphate strengthens this hypothesis. The fact that sugar, phosphate and oxygen have no further importance once a division has entered the prophase suggests either that energy is consumed only at the very beginning of the process, which seems unlikely, or that at this time energy is stored to be released as required during the course of the division. This latter theory is now being investigated. These results are to be published in full elsewhere.

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Dec. 5.

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Sodium Fluoroacetate as a Systemic and Contact Insecticide

It has been shown that many fluoroacetates are extremely toxic to mammals[1-3] and that some are powerful systemic and contact insecticides[4,5]. The salts of fluoracetic acid (notably sodium fluoroacetate) have been used as rodent poisons[5,6] ; but it appears that the insecticidal properties of these salts have not been recognized, since Schrader[5] states regarding them that "No contact insecticide action has yet been observed". Sodium fluoroacetate occurs in the poisonous South African plant gifblaar (*Dichapetalum cymosum*), and it seemed possible that it might be tolerated by other plants. For the above reasons, sodium fluoroacetate was tested as a contact and systemic insecticide. The material was prepared and kindly supplied by Dr. B. C. Saunders[3].

As in previous experiments[7], the biological tests were carried out in a greenhouse kept at about 15–25° C. The test insects were *Aphis fabæ* on broad beans.

Contact action. Dipping tests using 0·1 per cent 'Teepol' as a wetter showed that sodium fluoroacetate had a marked contact action. The lowest concentration giving a complete kill was 0·001 per cent w/v, which was effective in two days. A 0·01 per cent solution was effective in one day and in this case the plant was toxic to aphids applied two days later. By the fifth day the plants had lost their toxicity.

Absorption from the roots. Tests made with plants growing in soil and in sand-culture showed that sodium fluoroacetate was a highly effective systemic insecticide. As little as 1 mgm. added to a 3½-in. diameter pot containing about 400 gm. of soil freed the plant from aphids in five days. In sand 0·1 mgm. was effective. The treated plants remained toxic to aphids for ten days or more, depending on the amount applied.

In culture solutions the material was similarly effective, and complete kills of aphids have been obtained on plants supplied with 100 c.c. of a 0·00005 per cent w/v solution; that is, a maximum of 0·05 mgm. per plant weighing 10–15 gm.

Concentration in the plant necessary to kill the aphids. When applied to the cut tap-root and quickly absorbed by a plant, it was found that 0·1 mgm. was effective in one day, while 0·01 mgm. freed a plant of aphids in four days. The latter represents a concentration of 1 mgm. of sodium fluoroacetate per kilo of plant tissue.

Absorption from the leaves. When a 0·01 per cent w/v solution was allowed to drip on to one pair of leaves, it was found that from one to two days later the aphids began to fall off the leaf-pair situated on the same side of the stem above, and in favourable cases the whole plant was freed from aphids in four or five days. This suggests that the toxic material had reached the aphids on leaflets situated on the stem both above and below that to which the solution was applied. A similar absorption and distribution of plant hormones is said to occur.

Mode of action. Tests failed to show any vapour action with the solutions used, neither did the treated plant appear to transpire any toxic substance as occurs with *bis* (dimethylamino) fluorphosphine oxide. It must be concluded that the aphids were poisoned by the sap.

Tests against other insects. These are incomplete; but preliminary experiments show that a 0·0005 per cent solution of the fluoroacetate was effective systemically against the chrysanthemum aphid (*Macrosiphoniella sanborni*, Gill.) and the pea aphid (*Acyrthosiphum onobrychidis*, Fons.). When cultured on broad beans, the latter was more resistant than *Aphis fabæ*.

Effect on the plants. No detailed study has been made of the effects of sodium fluoroacetate on the plants. From observations made over fifteen days, however, it appears that broad beans begin to show injury at about 50–100 times the dose or concentration necessary to kill *Aphis fabæ*.

Minimum concentration giving complete kill	Sodium fluoroacetate	*bis* (*bis* Dimethylamino) phosphonous anhydride
Contact insecticide (% w/v)	0·001	0·03
Systemic insecticide (mgm./400 gm. sand)	0·1	12
Systemic in culture solution (%)	0·00005	0·0025
Concentration in plant (mgm./kilo plant tissue)	1	100

Comparison with bis (bis dimethylamino) phosphonous anhydride. Although fully adequate comparative tests have not been carried out, it appears that sodium fluoroacetate is more toxic to *Aphis fabæ* than phosphonous anhydride[7], as the accompanying table shows.

A more comprehensive investigation of the insecticidal action of sodium fluoroacetate is being made; but meanwhile it is perhaps well to emphasize its high mammalian toxicity. The median lethal dose (LD_{50}) for Norway rats is 0·22 mgm./kilo, which compares with 4·8 mgm./kilo for strychnine sulphate[6]. In the present state of knowledge it cannot be used as an insecticide and its hazards are completely unknown.

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Dec. 6.

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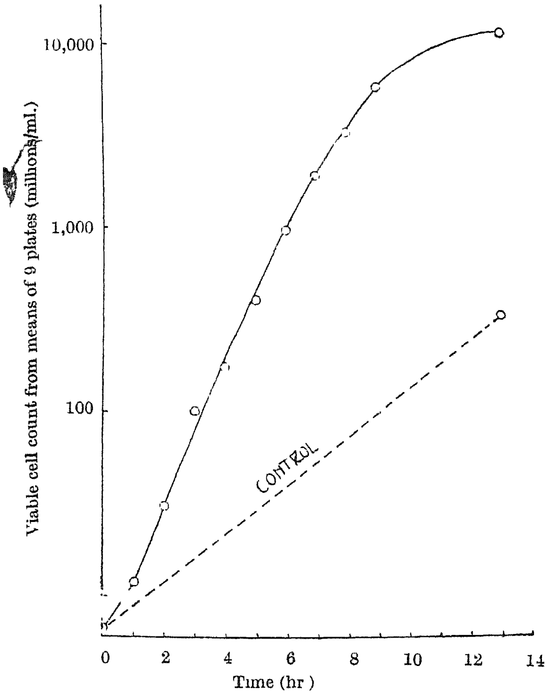
Influence of Aeration on Rate of Growth in Cultures

DURING a recent investigation, it was necessary to obtain large quantities of coliform organisms, free from agar extractives and from complex peptide material. While working with a simple medium containing ammonium salts (or asparagine) and dextrose, it was found that an enormous increase in growth could be obtained by passing air through the medium. The following conditions were found to be essential to the success of this procedure. (1) The aeration had to be violent and unremitting, and sufficient to maintain the whole of the medium in a state of turbulence. (2) Media of a more complex nature, giving a positive biuret reaction, frothed excessively, and the common foam suppressors failed to control it. (3) The cooling effect of such an air stream was considerable, and immersion of the culture bottle in a water-bath was necessary to overcome this. A practical method of dealing with it in an incubator could not be found. (4) A moderately complex system of air sterilization was unavoidable. (5) Carbon and nitrogen in the medium had to be adjusted to meet the increased growth.

The technique finally used for the preparation of mass cultures was as follows. A water-bath measuring 2 ft. by 2 ft. by 2 ft., electrically heated and loaded to 6 kW., and set at 39° C. was used. It was an advantage to have this wired to a time switch. Ten litres of medium was sterilized in a 20-litre bottle fitted with (1) an air inlet tube, the lower part of which was pressure tubing, leading to two 'Aerox' ceramic tubes, 2 in. by 3 in., porosity 28, lying in line horizontally on the floor of the bottle, (2) a wider air outlet leading to an 8-ft. length of rubber tubing which was paid out into a drain, and (3) an inoculation and sampling tube, the part in the medium being of rubber and the part outside the bottle entering a test-tube to make a syphon. The medium was inoculated with 200 ml.



of starter culture. Compressed air, sterilized by passing through sulphuric acid in a stainless steel pressure-tank, over dry sterile charcoal in a 3 ft. × 2½ in. steel cylinder and through a sterilized slag wool filter, was passed through the medium at about 0·75 cu. ft. per minute; this corresponded to a pressure of 4–6 lb. per sq. in. at the compressor end of the system. The growth approached its maximum at about 9 hr. and was harvested at 13 hr.

The growth of such a culture of *Bact. coli* is shown in the accompanying graph. In this example, the viable count of the aerated culture was thirty-four times greater than that of the control. In order to ensure that the full possibilities of the control medium had been exploited, it was incubated for a further 12 hr. Comparison of opacities after this showed a difference of twenty-three times between the two cultures, and the numbers of cells per ml. as estimated by opacity tubes was 24,000 million in the aerated culture and 1,100 million in the control.

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Dec. 8.

Formation of a Green Oxidation-Reduction Indicator in Plant Extracts

CERTAIN plants have been found to yield a thermostable system which slowly produces a blue-green pigment by atmospheric oxidation. After acidifying with hydrochloric acid, the green colour was changed to red. If the first green solution was allowed to stand, the green changed back to the original yellowish colour, with the exception of the surface layer, which remained greenish. Thus the above green pigment may serve as a natural indicator in various physiological investigations; its chemical nature is now under investigation.

An extract of the substance was prepared as follows. Yellow peelings of ripening 'Victoria' plums were put into boiling water, and the heating was discontinued immediately. After about thirty minutes, the extract was decanted; powdered sodium bicarbonate was added to bring the *p*H to 8–9, and the liquid was shaken with air. This produces the green pigment.

The same reaction was shown in extracts from the leaves of some other plants; as, for example, *Sanguisorba officinalis*, *Achillea millefolium*, *Convolvulus arvensis*, *Solidago virgo aurea*, *Taraxacum officinale* and *Sonchus* sp. Also yellow petals of these two latter showed a similar reaction.

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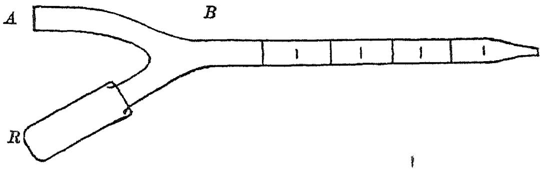
A Branched Pipette

A BRANCHED pipette similar to that described by Swallow[1] has been in use in my laboratory here since 1939. This was designed by me to expedite measurement of small quantities of liquid for rapid soil analysis, and a number were made by a London firm of glassblowers. In this pattern, the branches are Y-shaped and approximately symmetrical. Besides the advantage of rapid measurement, they are easily cleaned by directing a jet of water through the opening *A* and are also convenient to hang up in a hook or through a hole in a shelf.



In a slight variation of the pattern, the tube is expanded at *B* and is ground to fit the mouth of a bottle containing a liquid in frequent use. A loose-fitting cap is put over *A* if the liquid is volatile or is not in a situation protected from dust.

The parallel-sided rubber bulb, *R*, is preferable to the ordinary pear-shaped bulb.

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[1] Swallow, A. J., *Nature*, 165, 249 (1950).

Potato Tuber Eelworm and Iris Bulbs

FOR the past twenty-five years the identity of the nematode causing disease in bulbous irises has been in doubt. Investigations carried out in this Department during the past two years have proved conclusively that the potato tuber eelworm, *Ditylenchus destructor* Thorne, 1945, also infests bulbous irises belonging to Dutch, English and Spanish varieties. A full account of the investigations is being published elsewhere.

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March 13.

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Monday, March 27

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. T. H. Bridgewater: "The Operation and Maintenance of Television Outside-Broadcast Equipment".

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 5.30 p.m.—"The Maya through the Ages" (Colour film with sound commentary).

INSTITUTION OF THE RUBBER INDUSTRY, MANCHESTER AND DISTRICT SECTION (at the Engineers' Club, Albert Square, Manchester), at 6.15 p.m.—Mr. H. Whitcut: "Polytetrafluorethylene".

INSTITUTION OF WORKS MANAGERS, GLASGOW BRANCH (at the Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow), at 7 p.m.—Mr. J. A. Mack: "Philosophy of Industrial Management".

Tuesday, March 28

INSTITUTE OF FUEL (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. M. W. Thring: "High-Temperature Combustion-Heated Furnaces".*

ROYAL SOCIETY OF MEDICINE (at 1 Wimpole Street, London, W.1), at 5.30 p.m.—Discussion on "The Present Position of the Newer Antibiotics" (to be opened by Prof. L. P. Garrod).

INSTITUTION OF ELECTRICAL ENGINEERS, SCOTTISH CENTRE (at the Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow), at 7 p.m.—Mr. H. E. Dance: "Visual Methods in Engineering Teaching".

Tuesday, March 28—Monday, April 3

ROYAL METEOROLOGICAL SOCIETY.—Centenary Celebrations.

Tuesday, March 28 (at Oxford)

At 3.30 p.m.—Symposium on "Radiation and its Effect on the Troposphere and Lower Stratosphere".

Wednesday, March 29 (at Oxford)

At 9.30 a.m.—Symposium on "Physics of Cloud and Precipitation"; at 2.30 p.m.—Symposium on "The Structure of Weather Systems".

Thursday, March 30 (at Oxford)

At 9.30 a.m.—Symposium on "The General Circulation"; at 2.30 p.m.—Symposium on "Climatic Change".

Friday, March 31 (t Oxford)

At 9.30 a.m.—Symposium on "Meteorology and the Community".

Monday, April 3

At 10 a.m. (at the Imperial College of Science and Technology, South Kensington, London, S.W.7).—Discussion on "Atmospheric Turbulence"; at 3 p.m. (at 49 Cromwell Road, London, S.W.7).—Centenary Meeting.

Wednesday, March 29

PHYSICAL SOCIETY, LOW TEMPERATURE GROUP (in the Lecture Theatre, Royal School of Mines, Prince Consort Road, London, S.W.7), at 2.30 p.m.—Discussion on "The Thermodynamic Properties of Mixtures".

PHYSICAL SOCIETY, OPTICAL GROUP (in the Physics Department, Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 3 p.m.—Scientific Papers.

ROYAL STATISTICAL SOCIETY, RESEARCH SECTION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Symposium on "Ranking Methods".

INSTITUTION OF ELECTRICAL ENGINEERS, SUPPLY SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. G. Lyon: "Some Experience with a British A.C. Network Analyser".

INSTITUTION OF ELECTRICAL ENGINEERS, NORTH-WESTERN RADIO GROUP (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Dr. J. A. Pim: "The Electrical Breakdown Strength of Air at Ultra-High Frequencies".

Wednesday, March 29—Thursday, March 30

CHEMICAL SOCIETY (at Edinburgh).—Anniversary Meetings.

Wednesday, March 29

At 11 a.m. (in the Chemistry Department, King's Buildings, West Mains Road).—Sir Ian Heilbron, F.R.S.: "The Chemical Society, a Mid-Century Review" (Presidential Address); at 12 noon.—Annual General Meeting.

Thursday, March 30

At 11.30 a.m. (in the Zoology Department, King's Buildings, West Mains Road).—Prof. G. Hevesy, For.Mem.R.S.: "The Application of Radioactive Indicators in Biochemical Studies" (Faraday Lecture).

Wednesday, March 29—Friday, March 31

INSTITUTION OF NAVAL ARCHITECTS (on board the *Wellington*, Headquarters Ship of the Honourable Company of Master Mariners, Temple Stairs, Victoria Embankment, London, W.C.2), at 10.15 a.m. each day.—Spring Meeting.

INSTITUTE OF METALS.—Annual General Meeting.

Wednesday, March 29

At 10.30 a.m. (at the Café Royal, Regent Street, London, W.1).—Annual General Meeting; Mr. H. S. Tasker: Presidential Address; at 3.30 p.m. (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1).—Discussion of Papers.

Thursday, March 30

At 10 a.m. (at the Institution of Mechanical Engineers, St Gate, St. James's Park, London, S.W.1).—Symposium on "M gical Aspects of the Hot-Working of Non-Ferrous Metals and A

Friday, March 31

At 10 a.m. (at 4 Grosvenor Gardens, London, S.W.1).—Dis of Papers.

Thursday, March 30

BRITISH GLACIOLOGICAL SOCIETY (joint meeting with the INS OF REFRIGERATION, at the Royal Geographical Society, 1 Ken Gore, London, S.W.7), at 4.30 p.m.—Symposium on "The Dep of Ice on Exposed Surfaces".

ROYAL SOCIETY (at Burlington House, Piccadilly, London, at 4.30 p.m.—Scientific Papers.

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, V Embankment, London, W.C.2), at 5.30 p.m.—Symposium o M.K.S. System of Units".

ROYAL STATISTICAL SOCIETY, SHEFFIELD GROUP of the INDU APPLICATIONS SECTION (in Room B1, The University, St. G Square, Sheffield), at 6.30 p.m.—Mr. A. H. Dodd: "Variabi Chemical Analyses".

ROYAL INSTITUTE OF CHEMISTRY, LONDON AND SOUTH-EA COUNTIES SECTION (at Messrs. Philips Electrical, Ltd., New Mitcham Junction), at 7.15 p.m.—Dr. W. D. Jones: "The Prod of Heat Resisting Materials by Powder Metallurgy".

Thursday, March 30—Tuesday, April 4

BRITISH PSYCHOLOGICAL SOCIETY (at Reading).—Annual G Meeting.

Friday, March 31

INSTITUTION OF MECHANICAL ENGINEERS, STEAM GROUP (at St Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. B. and Mr. P. Betts: "A Contribution to the Theory of Natural Dr Cooling Towers".

Friday, March 31—Wednesday, April 5

PHYSICAL SOCIETY (at the Imperial College of Science and T logy, Imperial Institute Road, London, S.W.7), at 10 a.m. eac —Annual Exhibition of Scientific Instruments and Apparatus.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments before the dates mentioned:

RESEARCH OFFICER (chemist or biochemist) to study the position and structure of gelatine and glue—The Director of Re British Gelatine and Glue Research Association, 2–4 Dalmeny A London, N.7 (April 1).

SENIOR ASSISTANT IN THE DEPARTMENT OF SCIENCE AND R MATHEMATICS—The Principal, Aston Technical College, Wh Road, Birmingham 6 (April 1).

SENIOR EXAMINERS for the Textile, Metallurgical and C Laboratories in the Ministry of Supply Test House, Midd The Ministry of Labour and National Service, Technical and S Register (K), York House, Kingsway, London, W.C.2, quo 139/50A (April 1).

LECTURER IN DENTAL PATHOLOGY AND BACTERIOLOGY School of Dental Surgery—The Registrar, The University, Li (April 3).

SENIOR BIOLOGIST in the Fisheries and Game Branch, Dep of the Chief Secretary, Victoria—The Agent-General for V Victoria House, Melbourne Place, Strand, London, W.C.2, 'Biologist' (April 5).

LECTURER IN AGRICULTURAL BOTANY—The Secretary, The sity, Aberdeen (April 7).

ASSISTANT EXPERIMENTAL OFFICER IN THE ENTOMOLOGY MENT, for work on soil insects—The Secretary, Rothamsted mental Station, Harpenden, Herts (April 8).

LECTURER IN CHEMISTRY in the Leeds College of Technolog Chief Education Officer, Education Department, Leeds 1 (Ap

RESEARCH ASSISTANT IN ZOOLOGY (graduate specially qua entomology and helminthology), and a DEMONSTRATOR and ASSISTANT IN THE BOTANY DEPARTMENT (with science degr ferably honours, and special qualifications in botany)—The Se West of Scotland Agricultural College, 6 Blythswood Square, (April 8).

ASSISTANT TO THE CHIEF SAFETY ENGINEER in the Pro Department at London headquarters—The National Coal Establishments Branch (Personnel), Hobart House, Grosveno London, S.W.1, quoting TT/207 (April 11).

SENIOR LECTURER IN BOTANY at the University of Weste tralia—The Agent-General for Western Australia, 115–116 London, W.C.2 (April 17).

AGRONOMIST IN THE RESEARCH DIVISION of the Ministry culture and Forests, Sudan—The Sudan Agent in London, W House, Buckingham Gate, London, S.W.1, endorsed 'Agron

HEAD OF THE DEPARTMENT OF OPHTHALMIC OPTICS, and a L IN METALLURGY in the Department of Applied Chemist Secretary, Northampton Polytechnic, St. John Street, Londo

LECTURER IN ELECTRICAL ENGINEERING—The Principal, T College, Queen Street South, Huddersfield.

RESEARCH ASSISTANT (Technician or B.Sc. graduate) for biological assays of vitamin B_{12} and folic acid—The Registrar College, Newcastle-upon-Tyne.

ELECTRICAL ENGINEER (Electronic) on the Headquarters the London Office—The Crown Agents for the Colonies, 4 London, S.W.1, quoting M.N.25333(3B).